SOIL SURVEY OF GARFIELD COUNTY AREA, WASHINGTON

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE WASHINGTON AGRICULTURAL EXPERIMENT STATION

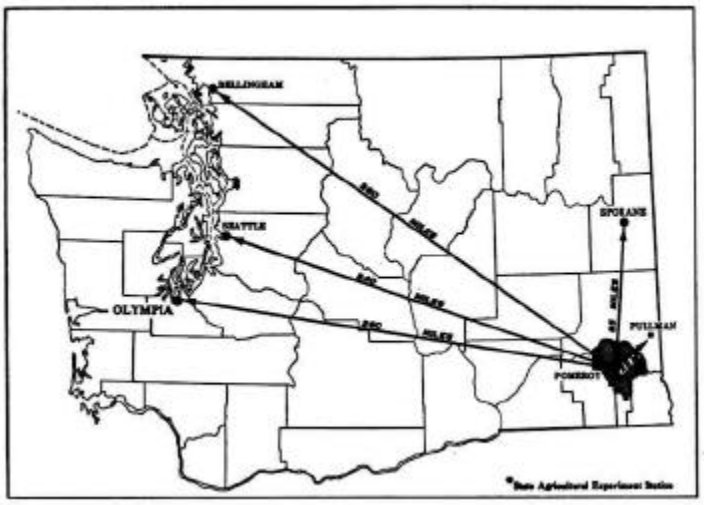

Figure 1.-Location of the Garfield County Area in Washington.

THE GARFIELD COUNTY AREA is in the southeastern part of Washington (fig. 1). It consists of 349,690 acres, or all of Garfield County except the southern part, which is within the Umatilla National Forest. The Snake River forms the northern boundary of the county. Elevations range from 600 feet, at a point along the Snake River, to about 4,600 feet, at a point along the southern boundary. More than half the residents of the county live in Pomeroy, the county seat.

The survey area consists largely of broad, gently sloping to strongly sloping ridges divided by many small streams. About 3 percent of the Area is forested; the forests are in the Blue Mountains along the southern boundary.

Wheat is the major cultivated crop, to which the soils in most of the survey area are well suited. Barley is the next most important crop; grass seed and peas are also produced. The soils in the southern part of the survey area are not generally suitable for cultivation. They are used mainly for grazing, recreation, and lumbering.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Garfield County Area, where they are located, and how they can be used. The soil scientists went into the survey area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kind of native plants or crops, the kinds of rock, and many more facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series commonly is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Athena and Lance, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Athena silt loam, 0 to 7 percent slopes, is one of several phases within the Athena series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in 1

planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such mapping unit shown on the soil map of the Garfield County Area is the soil complex.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Athena-Lance silt loams, 10 to 40 percent slopes, eroded, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Riverwash is a land type in this survey area.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data, from the same kind of entering other places are also assembled-Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Garfield County Area. A soil association is a landscape that .has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning. engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field; or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in the Garfield County Area are discussed in the following pages. The terms for texture used in the title of the associations apply to the surface layer. For example, in the title for association 1, the words "silt loam" refer to the texture of the surface layer.

1. Chard-Lickskillet-Walla Walla association

*Deep and very deep, strongly sloping to steep silt loams and shallow, moderately steep to very steep, extremely stony and rocky soils; 12 to 16 inches annual precipita*tion

This association consists of well-drained soils that formed in wind- or water-deposited material and in material weathered from basalt bedrock. These soils are mainly strongly sloping to very steep but range from nearly level to very steep. The association is on uplands and terraces in the northwestern and east-central parts of Garfield County Area. The uplands and higher terraces are dissected by very steep slopes that extend down to deep, intermittent drainageways. Water flows in these drainageways only during periods of rapid runoff. These streams empty into Alpowa, Deadman, Meadow, and Pataha Creeks.

The vegetation is mainly bunchgrass and rabbitbrush. Elevation ranges from 600 to 2,500 feet. The annual precipitation is 12 to 16 inches. Summers are hot and dry; winters are cool and moist. The mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

This association makes up 66,440 acres, or about 19. percent of the survey area. Chard soils make up about 31 percent of the association, Lickskillet soils 23 percent. Walla, Walla soils 12 percent; and Oliphant soils 8 percent. The remaining 26 percent of the association consists of soils of the Alpowa, Anders, Asotin, Bakeoven, Benge, Henningsen, Hermiston, Onyx, Quincy, and Spofford series.

Chard soils have a surface layer of silt loam or very fine sandy loam and a subsoil of loam. They are more than 40 inches deep. These soils are on high terraces, steep sides of terraces, and low terraces along the Snake River. Exposures are dominantly north and east.

Lickskillet soils are extremely stony silt loam throughout. They are 12 to 20 inches deep over basalt. Most areas

are moderately steep to very steep. Exposures are south and west.

Walla Walla soils are silt loam throughout. They are more than 40 inches deep. Exposures are north and east.

Oliphant soils are silt loam throughout and are more than 40 inches deep. They are calcareous at a depth of about 28 inches. Exposures are south and west.

This association is used for dryland farming, range, recreation, wildlife habitat, water supply, and watershed protection. The farms are about 1,200 to 1,600 acres in size. They are used for both range and dryland farming.

About 60 percent of the association consists of extremely stony or very steep soils that are used for range. Of the soils used for range, Lickskillet soils have low potential for forage production, and Oliphant and Walla Walla soils have high potential. There are very few springs in the association and few sites that are suitable for stock tanks or ponds. Water is usually in short supply, and, as a result, grass near watering places is generally overgrazed and grass a long distance from water is undergrazed.

The Chard and Walla Walla soils are tillable, and most areas of these nearly level to steep soils are farmed. Wheat, barley, grass, and alfalfa are commonly grown. A summer fallow system of farming is used because the annual rainfall is low.

Runoff comes mostly from the Lickskillet soils and areas of other soils in range that is in poor or fair condition. The runoff carries small amounts of silt from range areas and small to moderate amounts of silt from tilled areas.

Roads follow the bottoms of the incised canyons along the drainageways. U.S. Highway 12 and State Route 127 cross this association. The communities of Central Ferry and Dodge are in this association. Farmsteads generally are on bottom lands along drainageways and on terraces of the Snake River.

2. Oliphant-Walla Walla-Lickskillet association

Deep and very deep, strongly sloping to moderately steep silt loams and shallow, moderately steep to very steep, extremely stony and rocky soils; 16 to 10 inches annual precipitation

This association consists mainly of well-drained soils that formed in wind- or water-deposited material and material weathered from basalt bedrock. These soils are mainly strongly sloping to moderately steep but range from nearly level to very steep. The association is on uplands and terraces in the northwestern part of Garfield County Area. The uplands are dissected by very steep slopes that extend down to deep, intermittent drainageways. Water flows in these drainageways only during periods of rapid runoff. These streams empty into Deadman, Meadow, and Pataha Creeks.

The vegetation is mainly bunchgrass and rabbitbrush. Elevation ranges from 600 to 3,000 feet. The annual precipitation is 12 to 16 inches. Summers are hot and dry; winters are cool and moist. The mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

This association makes up 83,930 acres, or about 24 percent of the survey area. Oliphant soils make up about 30 percent of the association. Walla Walla soils 25 percent, and Lickskillet soils 12 percent. The remaining 33 percent of the association consists of soils of the Alpowa, Anders, Asotin, Bakeoven, Benge, Chard, Henningsen, Hermiston, Lance, Onyx, and Spofford series.

Oliphant soils are silt loam and more than 40 inches deep. They are calcareous at a depth of 28 inches. Exposures are south and west.

Walla Walla soils are silt loam and are more than 40 inches deep. Exposures are north and east.

Lickskillet soils are extremely stony silt loam and are 12 to 20 inches deep over basalt. Most areas are moderately steep to very steep. Exposures are south or west.

This association is used for dryland farming, range, recreation, wildlife habitat, water supply, and watershed protection. The farms are about 1,200 acres in size. They are used for both range and dryland farming.

About 60 percent of the association is farmed. The major tillable soils are those of the Oliphant and Walla Walla series. Wheat, barley, grass, and alfalfa are commonly grown. A summer fallow system of farming is used because the annual rainfall is low.

Most of the rest of the association consists of extremely stony or very steep soils used for range. Of the major soils used for range, Lickskillet soils have low potential for forage production, and Oliphant and Walla Walla soils have high potential. There are very few springs in the association and few, sites that are suitable for stock tanks or ponds. Water is usually in short supply, and, as a result, grass near watering places is generally overgrazed and grass a long distance from water is undergrazed.

Runoff comes mostly from the Lickskillet soils and areas of other soils in range that is in poor or fair condition. The runoff carries small amounts of silt from range areas and small to moderate amounts of silt from tilled areas.

Roads, both surfaced and unsurfaced, follow the long ridgetops and bottoms of canyons along the drainageways. U.S. Highway 12 crosses this association. The communities of Gould City, Pataha, and Pomeroy are in this association. Farmsteads are scattered throughout the association, mainly on bottom lands along the drainageways.

3. Athena-Asotin association

Deep and very deep, gently sloping to moderately steep silt loams; 16 to 20 inches annual precipitation

This association consists of well-drained soils that formed in wind-deposited material and in material weathered from basalt bedrock. These soils are mainly gently sloping to moderately steep but range from nearly level to very steep. The association is on uplands in the northeastern and central parts of Garfield County. The uplands are dissected by deep, intermittent drainageways that flow into North Deadman, South Deadman, North Meadow, South Meadow, Casey, Linville, and Pataha Creeks.

The vegetation is mainly bunchgrass. Elevation ranges from 1,850 to 3,400 feet. The annual precipitation is 16 to 20 inches. Summers are warm and dry; winters are cool and moist. The mean annual temperature is about 49° F. The frost-free season is 135 to 145 days.

This association makes up 144,550 acres, or, about 41 percent of the survey area. Athena soils make up about 75 percent of the association, and Asotin soils, high rainfall, makes up 10 percent. The remaining 15 percent of the association consists of soils of the Gwin, Henningsen, Lance, Linville, Mondovi, and Spofford series.

Athena soils are silt loam and are more than 40 inches deep. The soils are noncalcareous in areas where exposures are north and east. They are calcareous at a. depth of 40 to 60 inches in areas where exposures are south or west.

Asotin soils are silt loam and are 23 to 38 inches deep to basalt bedrock. They are nearly level to steep. Exposures are south and west.

This association is used for dryland farming, range, recreation, wildlife habitat, water supply, and watershed protection.. The farms are about 1,000 acres in size. They are used for both range and dryland farming.

About 80 percent of this association is farmed. The major soils are tillable where they are not too steep or too stony. Wheat, barley, grass, and alfalfa are commonly grown. A summer fallow system of farming is used.

Most of the remaining acreage is made up of extremely stony or very steep soils used for range. Of these soils, Athena and Asotin, high rainfall, soils have high potential for forage production. Water is in short supply in some areas, and, as a result, grass near watering paces is generally overgrazed and grass a long distance from water is undergrazed.

Runoff comes mostly from areas of range that are in poor or fair condition. The runoff carries small amounts of silt from range areas and small to moderate amounts of silt from tilled areas.

Roads, both surfaced and unsurfaced, cross this association. Unsurfaced roads are soft and sticky and nearly impassable in wet weather. U.S. Highway 12 and State Highway 128 cross the association. The community of Mayview is in this area. Farmsteads are scattered throughout the association.

4. Gwin-Linville association

Shallow, moderately steep to very steep, extremely stony soils and very deep, steep to very steep silt loams; 16 to 20 inches annual precipitation

This association consists of well-drained soils that formed in wind-deposited material and in material weathered from basalt bedrock. These soils are moderately steep to very steep. The association is on uplands and terraces in the northeastern part of the county. Water flows off the uplands during periods of rapid runoff and drains into the Snake River.

The vegetation is shrubs, a few trees, and mixed grasses. Elevation ranges from 800 to 2,500 feet, but in most places it is more than 1,100 feet. The annual precipitation is 16 to 20 inches. Summers are warm and dry; winters are cool and moist. The mean annual temperature is about 48° F. The frost-free season is 120 to 140 days.

This association makes up 20,980 acres, or about 6 percent of the survey area. Gwin soils make up about 63 percent of the association, and Linville soils make up about 32 percent. The remaining 5 percent of the association consists of soils of the Alpowa, Benge, Chard, and Quincy series.

Gwin soils are extremely stony silt loam and are 12 to 20 inches deep to basalt bedrock. They are moderately steep to very steep. Exposures are south and west.

Linville soils are silt loam; they are steep to very steep. Exposures are north and east.

This association is used for range, recreation, wildlife habitat, and watershed protection. Most of the terraces are above the Lower Granite Damsite on the Snake River and are owned by the Federal Government. The areas used for range are part of range areas in adjoining associations.

About 95 percent of this association is used for range. Gwin soils have low to medium potential for forage production, and Linville soils have high potential. Use of the soils for grazing is difficult in areas of very steep soils.

Runoff comes mainly from the Gwin soils and areas of the Linville soils in range that is in poor or fair condition. The runoff carries small amounts of silt.

Three roads, two surfaced and one unsurfaced, follow the drainageways from, the uplands down to the Snake River. One surfaced road follows the river for about 6 miles. The Lower Granite Damsite, on the Snake River, is in this association.

5. Gwin-Waha-Palouse association

Shallow, moderately steep to very steep, extremely stony soils and moderately deep to very deep, nearly level to steep silt loams; 20 to 24 inches annual precipitation

This association consists of well-drained soils (fig. 2) that formed in wind deposited material and in material weathered from basalt bedrock. These soils are nearly level to very steep. The association is in foothills between Pataha Flats and the Blue Mountains. The foothills are dissected by deep, intermittent drainageways that flow into perennial streams. Tumalum Creek flows in a northwesterly direction, Pataha Creek flows northerly, and Alpowa and Pow-Wah-Kee Creeks flow northeasterly.

The vegetation is mainly mixed grasses and shrubs. Ponderosa pine, hawthorn, and willow grow on east- and north-facing slopes along streams. Elevation ranges from 3,000 to 4,500 feet. The annual precipitation is 20 to 24 inches. Summers are warm and dry; winters are cold and wet. The mean annual temperature is about 47° F. The frost-free season is 115 to 135 days.

This association makes up 15,310 acres, or about 4.4 percent of the survey area. Gwin soils make up about 40 percent of the association, Waha soils 25 percent, and Palouse soils 25 percent. The remaining 10 percent of the association consists of soils of the Linville and Henningsen series.

Gwin soils are extremely stony silt loam and are 12 to 20 inches deep to basalt bedrock. They are moderately steep to very steep. Exposures are south and west.

Waha soils have a surface layer of silt loam and a subsoil of silty clay loam. They are 24 to 40 inches deep over basalt bedrock. They are nearly level to steep. Exposures are north and east.

Palouse soils are silt loam and are more than 40 inches deep to basalt bedrock. They are nearly level to steep. Exposures are north and east.

This association is used for dryland farming, range, recreation, wildlife habitat, water supply, and watershed

Figure 2.--An area of the Gwin-Waha-Palouse association where it joins the Larkin-Gwin-Tolo association. The soil in the foreground is Gwin extremely stony silt loam, 10 to 50 percent slopes; the soil in the right background is Palouse silt loam, 7 to 25 percent slopes. This area is in the east half of sec. 8, T.10 N., R. 42 E.

protection. The farms are about 800 to 1,000 acres in size. They are used for both range and dryland farming.

About 50 percent of this association is used for range. Gwin soils have medium potential for forage production, and Waha and Palouse soils have high potential. Use of the soils for grazing is difficult in very steep areas.

The nearly level to steep areas of the Waha and Palouse soils are tillable. Wheat, barley, grass, and alfalfa are commonly grown. Both summer fallow and annual cropping systems are used. Rainfall is adequate for raising crops annually except in very dry years.

Runoff comes mostly from Gwin soils and areas of other soils in range that is in poor or fair condition. The runoff carries small amounts of silt from range areas and small to moderate amounts of silt from tilled areas.

Roads, both surfaced and unsurfaced, follow ridgetops and drainageways. State Highway 128 crosses the association. Unsurfaced roads are soft, very sticky, and nearly impassable in wet weather. Farmsteads are scattered throughout the association.

6. Larkin-Gwin-Tolo association

Deep and very deep, strongly sloping to steep silt loams and shallow, moderately steep to very steep, extremely stony soils; 20 to 30 inches annual precipitation

This association consists of well-drained soils that formed in wind-deposited material and in material weathered from basalt bedrock. These soils are mainly strongly sloping to very steep but range from nearly level to very steep. The association is on mountain uplands in the southern part of the survey area. It borders the Umatilla National Forest. The uplands are dissected by intermittent drainageways in deep canyons; the drainageways empty into perennial streams. Tumalum and Pataha Creeks flow in a northerly direction, and Charlie Creek flows easterly.

The vegetation is ponderosa pine, Douglas-fir, scattered larches, shrubs, and scattered areas of mixed grasses. Elevation ranges from 3,000 to 4,500 feet. The annual precipitation is 20 to 30 inches. Summers are warm and dry; winters are cold and wet. The mean annual temperature is about 46° F. The frost-free season is 100 to 120 days.

This association makes up 18,480 acres, or about 5.3 percent of the survey area. Larkin soils make up 36 percent of the association, Gwin soils 24 percent, and Tolo soils 12 percent. The remaining 28 percent of the association consists of soils of the Anatone, Klicker, Linville**,** and Waha series.

Larkin soils have a surface layer of silt loam and a subsoil of silty clay loam. These soils are more than 42 inches, but less than 60 inches, deep to basalt bedrock. They are nearly level to very steep. Exposures are north and east.

Gwin soils are extremely stony silt loam and are 12 to 20 inches deep to basalt bedrock. They are moderately steep to very steep. Exposures are south and west.

Tolo soils have a surface layer of silt loam, mostly volcanic ash, and a subsoil of silty clay loam. They are moderately steep to very steep and are more than 60 inches deep to basalt bedrock. Exposures are north.

This association is used for woodland, range, recreation, wildlife habitat, dryland farming, and water supply. In most places the farms are partly in adjoining associations.

About 58 percent of this association is used for production of timber. The open ridgetops and the open south- or west-facing slopes are used mainly for range, but scattered areas are used for farming. Gwin soils have medium potential for forage production.

The nearly level to moderately steep areas of Larkin soils on open ridgetops are farmed. Wheat is the common grain crop, and grass is the common hay and pasture crop.

Runoff comes mostly from the Gwin soils or from cutover areas of woodland. In most places the runoff carries only small amounts of silt.

Surfaced and unsurfaced roads, trails, and logging roads cross this association. Unsurfaced roads are soft, sticky, and nearly impassable in wet weather. The communities of Columbia Center and Peola are in this association. There are a few homesteads.

Descriptions of the Soils

This section describes the soil series and mapping units in the Garfield County Area. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

The series descriptions are in alphabetic order. Following each series description is a fairly detailed description of one mapping unit of the series. This detailed description is followed by brief descriptions of the rest of the mapping units.

In each series description is a short narrative description of a profile representative of the series. In the first mapping unit description is a much more detailed description of the same profile, which can be used by scientists, engineers, and others in making highly technical interpretations. Unless otherwise stated, the color names and color symbols given are for dry soils.

As mentioned in the section “How This Survey Was Made,” not all mapping units are members of a soil series. Riverwash, for example, does not belong to a soil series, but nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability' unit, range site, windbreak group, and woodland group in which the mapping unit has been placed. The page for the description of each mapping unit and of each interpretive group can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (10).

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Alpowa Series

The Alpowa series consists of well-drained soils of the uplands. These soils formed under grass in a mixture of loess, alluvium, and basalt colluvium. Bedrock is at a depth of 40 to more than 60 inches. Elevations range from 600 to 3,000 feet. Slopes are 10 to 65 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

In a representative profile the surface layer is grayish-brown, slightly hard very stony silt loam about inches thick. The substratum is brown gravelly and cobbly silt loam to a depth of 15 inches. Below this is pale brown and very pale. brown, slightly hard gravelly and cobbly loam and silt loam that is strongly calcareous. The soil is mildly alkaline in the surface layer and moderately alkaline to strongly alkaline below the surface layer.

Soils of the Alpowa series are used mostly for range.

Alpowa-very stony silt loam, 25 to 65 percent slopes (AaF).-This soil is in areas that are as much as a mile in length and that average about 200 feet in width. It is on foot slopes where the dominant slope is 35 to 55 percent.

Representative profile, in grassland, 600 feet east and 620 feet south of the northwest corner of sec. 20, T. 11 N., R. 44 E.

A1-0 to 7 inches, grayish-brown (10YR 5/2) very stony silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; about 30 percent basalt cobblestones, stones, and gravel; mildly alkaline; clear, wavy boundary.

C1-7 to 15 inches, brown (10YR 5/3) gravelly and cobbly silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; 35 percent gravel and cobblestones; moderately alkaline; clear, wavy boundary.

C2ca-15 to 31 inches, pale-brown (10YR 6/3) gravelly and cobbly silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; 40 percent gravel and cobblestones; violent effervescence; moderately alkaline; gradual, wavy boundary.

C3ca-31 to 49 inches, very pale brown (10YR 7/3) gravelly and cobbly loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; 45 percent gravel and cobblestones; violent effervescence; strongly alkaline; gradual, wavy boundary.

C4ca-49 to 60 inches, light yellowish-brown (10YR 6/4) gravelly and cobbly coarse sandy loam, dark yellowish brown (10YR 4/4) moist; massive; loose; nonsticky and nonplastic; common roots; 45 percent cobblestones and gravel; violent effervescence; strongly alkaline.

Stones cover 2 to 10 percent of the surface. Bedrock begins at depths of 40 to more than 60 inches.

Included with this soil in mapping were small areas where the slope is less than 25 percent, areas that have only scattered stones in the surface layer, and other areas that are less than 40 inches deep to bedrock. Rock crops out in about 1 to 6 percent of the acreage.

Permeability is moderate, and roots penetrate to bedrock or to a depth of more than 60 inches. The soil holds about 6 to 7 inches of water that plants can use. Runoff

is rapid; most of it comes during rainstorms in spring and severe thunderstorms in summer. The hazard of water erosion is severe, but there is no hazard of wind erosion.

This soil is used mainly for range. It is not suitable for cultivation. (Capability unit VIIs-1; North Exposure range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Alpowa very stony silt loam, 10 to 25 percent slopes (AaD).- This soil is in long, narrow areas on foot slopes of drainageways off the basalt plateau. It also occurs in small areas on alluvial fans at the mouths of drainage ways. It is similar to Alpowa very stony silt loam, 25 to 65 percent slopes, except for slope.

Included with this soil in mapping were small areas where the slope is more than 25 percent, areas where the surface layer contains only scattered stones, and areas where bedrock is at a depth of less than 40 inches.

Runoff is slow to medium. The hazard of water erosion is slight to moderate.

This soil is used mainly for range. (Capability unit VIIs-1; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Anatone Series

The Anatone series consists of well-drained soils of the uplands. These soils formed under bunchgrass and sagebrush in material weathered from basalt mixed with wind-laid silt and some volcanic ash. Basalt begins at a depth of 10 to 20 inches. Elevations range from 3,500 to 4,500 feet. Slopes are 10 to 30 percent. The annual precipitation is 22 to 30 inches, and the mean annual temperature is about 46° F. The frost-free season is 110 to 130 days.

In a representative profile the surface layer is reddish-brown very cobbly and gravelly loam. Bedrock is at a depth of 17 inches. The soil is neutral to slightly acid.

Soils of the Anatone series are used mainly for range.

Anatone extremely stony loam, 10 to 30 percent slopes WcE).-This soil is on ridgetops in the southern part of the survey area. Slopes are short, and in most places the gradient is 10 to 20 percent.

Representative profile, 1,720 feet south and 640 feet west of the northeast corner of sec. 32, T. 10 N., R. 42 E.

A1-0 to 4 inches, reddish-brown (5YR 4/4) extremely stony loam, dark reddish brown (2.5YR 2/3) moist; weak, line, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; about 60 percent stones, cobblestones, and gravel; neutral; clear, wavy boundary.

B2-4 to 15 inches, reddish-brown (5YR 4/4) very gravelly and cobbly loam, dark reddish brown (5YR 3/3) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common roots; few very fine pores; thin cutans on ped surfaces; slightly acid; abrupt, wavy boundary.

C-15 to 17 inches, broken and fractured basalt; material from the B2 horizon in the fractures; few roots.

R-17 inches, basalt bedrock.

The depth to bedrock ranges from 10 to 20 inches. The texture throughout the profile is loam, silt loam, silty clay loam, or clay loam. The soil material is 22 to 30 percent clay and 50 to 75 percent gravel, cobblestones, and stones. The color range is in hues of 2.5YR, 5YR, and 7.5YR, values of 3 or 4, and chromas of 3 or 4.

Included with this soil in mapping were small areas where bedrock is at a depth of 3 to 10 inches. Rock outcrops cover 3 to 10 percent of the acreage.

Permeability is moderate, and roots penetrate to bedrock. The soil holds 1 to 2 inches of water that plants can use. Runoff is medium to rapid, depending on the slope; most of it comes during snowmelt early in spring. The hazard of water erosion is moderate to severe.

This soil is used mainly for range. (Capability unit VIIs-2 ; Shallow range site, 16 to 24 inches precipitation; windbreak group 7; not in a woodland group)

Anders Series

The Anders series consists of well-drained soils of the uplands. These soils formed under bunchgrass in wind-laid silt. Basalt bedrock begins at a depth of 20 to 40 inches. Elevations range from 600 to 2,550 feet. Slopes are 0 to 25 percent. The annual precipitation in 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 150 days.

In a representative profile the surface layer is dark grayish-brown, slightly hard silt loam about 12 inches thick. The subsoil is brown, slightly hard silt loam that is about 18 inches thick and extends to bedrock. The soil is neutral in the surface layer and mildly alkaline in the subsoil.

Soils of the Anders series are used mainly for small grain, hay, pasture, and range.

Anders silt loam, 0 to 7 percent slopes (AdB).-This soil is on uplands. The areas range from 16 to 35 acres in size. Slopes are dominantly 3 to 7 percent.

Representative profile, 350 feet east and 1,000 feet north of the southwest corner of sec. 21, T. 13 N., R. 40 E.

A11-0 to 4 Inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; neutral; clear, wavy boundary.

A12-4 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; scattered gravel; neutral; clear, wavy boundary.

B21-12 to 16 Inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; 1 to 2 percent gravel; mildly alkaline; gradual, wavy boundary.

B22-16 to 30 Inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine and few fine pores; 3 percent gravel; mildly alkaline; abrupt, smooth boundary.

IIR-30 inches, basalt bedrock.

The depth to bedrock ranges from 20 to 40 inches.

Included with this soil in mapping were small areas where the slope is more than 7 percent, areas where bedrock begins at a depth of less than 20 inches or more than 40 inches, and areas where the surface layer is gravelly.

Permeability is moderate, and roots penetrate to bedrock. The soil holds 4 to 7 inches of water that plants can use. Runoff is slow; most of it comes from melting snow

early in spring and during rainstorms late in spring and in fall. The hazards of water erosion and wind erosion are slight.

Wheat, barley, alfalfa, and grass are the principal crops. (Capability unit IIIe-2; windbreak group 1; not in a range or woodland group)

Anders-Lickskillet complex, 5 to 25 percent slopes (AeD).-This complex is on basalt plateaus. It is about 60 percent Anders silt loam and about 40 percent Lickskillet extremely stony silt loam. The Anders soil occurs as mounds; these are roughly circular, are 15 to 60 feet across, and locally are called biscuits. The Lickskillet soil occupies the shallow valleys, or swales, between the mounds.

Runoff is medium to rapid; most of it comes from melting snow early in spring. The hazard of erosion is moderate to severe.

This complex is used mainly for range and wildlife habitat: (Capability unit VIIs-1; Anders part in Loamy range site, 12 to 16 inches precipitation; Lickskillet part in Shallow range site, 12 to 16 inches precipitation; both parts in windbreak group 7; neither part in a woodland group)

Asotin Series

The Asotin series consists of well-drained soils of the uplands. These soils formed under bunchgrass and sagebrush in calcareous loess. Bedrock begins at a depth of 20 to 40 inches. Elevations range from 600 to 2,550 feet. Slopes are 0 to 40 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

In a representative profile the surface layer is dark grayish-brown, slightly hard silt loam about 10 inches thick. The subsoil is brown, hard heavy silt loam that extends to an average depth of about 20 inches. The substratum is pale-brown, slightly hard, calcareous silt loam that extends to bedrock at a depth of about 27 inches. The soil is mildly alkaline in the surface layer, moderately alkaline in the subsoil, and strongly alkaline below the subsoil.

Soils of the Asotin series are used mainly for small grain, hay, pasture, and range.

Asotin silt loam, 7 to 25 percent slopes (AlD).-This soil is on side slopes that descend from basalt plateaus. The areas are generally 10 to 80 acres in size.

Representative profile, 2,000 feet south and 450 feet east of the northwest corner of see. 21, T. 12 N., R. 40 E.

Ap-0 to 7 inches, dark grayish-brown (l0YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly plastic; many roots; neutral; abrupt, smooth boundary.

A1-7 to 10 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; mildly alkaline; clear, wavy boundary.

B2t-10 to 20 inches, brown (10YR 5/3) heavy silt loam, dark brown (10YR 3/3) moist; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; hard, friable, sticky and plastic; common roots; many very fine pores; thin patchy cutans on ped surfaces and in pores; moderately alkaline; abrupt, wavy boundary.

Cca-20 to 27 inches, pale-brown (l0YR 6/3) silt loam, dark brown (l0YR 4/3) moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; common roots; many very fine pores; 10 percent angular basalt gravel; violent effervescence; strongly alkaline; abrupt, wavy boundary.

IIR-27 inches, basalt bedrock.

The depth to bedrock ranges from 20 to 40 inches.

Included with this soil in mapping are small areas where the slope is less than 7 percent or more than 25 percent and areas where bedrock begins at a depth of less than 20 inches or more than 40 inches. Also included are areas where the surface layer is gravelly.

Permeability is moderate, and roots penetrate to bedrock. The soil holds 4 to 7 inches of water that plants can use. Runoff is medium to rapid; most of it comes from melting snow in winter and early in spring and from rainstorms in spring and thunderstorms in summer. The hazard of water erosion is moderate, and the hazard of wind erosion is slight.

Wheat, barley, alfalfa, and grass are the principal crops. (Capability unit IVe-3; windbreak group 1; not in a range site or woodland group)

Asotin silt loam, 0 to 7 percent slopes (AlB).- This soil is in areas that are more than a mile long in places and that average about 300 feet in width. It occurs along the rims of basalt plateaus and follows the contour. The soil is similar to Asotin silt loam, 7 to 25 percent slopes, except for sloe. In most places the slope is 3 to 7 percent.

Included with this soil in mapping were small areas where the slope is more than 7 percent, areas where bedrock is at a depth of less than 20 inches or more than 40 inches, and areas where the surface layer is gravelly.

Runoff is slow, and the hazards of water erosion and wind erosion are slight.

This soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IIIe-2; windbreak group 1; not in a range site or woodland group)

Asotin silt loam, 25 to 40 percent slopes (AlE).-This soil is on side slopes descending from basalt plateaus. It is similar to Asotin silt loam, 7 to 25 percent slopes, except for slope. The areas range from 10 to 80 acres in size.

Included with this soil in mapping were small areas where the slope is less than 20 percent or more than 40 percent, areas where bedrock is at a depth of less than 20 inches or more than 40 inches, and areas where the soil is stony.

Runoff is rapid. The hazard of water erosion is severe, but the hazard of wind erosion is only slight.

This soil is used mainly for range and for wildlife habitat. (Capability unit VIe-1; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Asotin silt loam, high rainfall, 0 to 15 percent slopes (AmC).-This soil occurs along the edge of a basalt plateau. The areas are more than a mile long and are about 300 feet in width. The soil is similar to Asotin silt loam, 7 to 25 percent slopes, except that the annual precipitation is 16 to 20 inches and the surface layer is very dark brown and about 4 inches thicker. In most places the slope is 3 to 12 percent.

Included with this soil in mapping were areas where the slope is more than 15 percent, areas where bedrock

is at a depth of less than 20 inches or more than 40 inches, and areas where the surface layer is gravelly.

Runoff is slow to medium, and the hazard of water erosion is moderate. The soil holds 5 to 8 inches of water that plants can use.

This soil is used mainly for wheat, barley, grass, and alfalfa. (Capability unit IIIe-4; windbreak group 2; not in a range site or woodland group)

Asotin silt loam, high rainfall, 15 to 25 percent slopes (AmD).-This soil is on the sides of a basalt plateau. It is similar to Asotin silt loam, 7 to 25 percent slopes, except that the annual precipitation is 16 to 20 inches and the surface layer is thicker. The areas range from 10 to 80 acres in size.

Included with this soil in mapping were small areas where the slope is less than 15 percent or more than 25 percent, areas where bedrock is at a depth of less than 20 inches or more than 40 inches, and areas where the surface layer is gravelly.

Runoff is medium to rapid, and the hazard of water erosion is moderate to severe. The soil holds about 5 to 8 inches of water that plants can use.

This soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IVe-6; windbreak group 2; not in a range site or woodland group)

Asotin silt loam, high rainfall, 25 to 40 percent slopes (AmE).-This soil is on the sides of a basalt plateau. It is similar to Asotin silt loam, 7 to 25 percent slopes, except that the annual precipitation is 16 to 20 inches, the surface layer is thicker, and the soil is more sloping. The areas range from 10 to 60 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent, areas where bedrock is at. a depth of less than 20 inches or more than 40 inches, and areas where the soil is stony.

Runoff is rapid, and the hazard of water erosion is severe. The soil holds about 5 to 8 inches of water that plants can use.

This soil is used mainly for range. (Capability unit VIe-2 ; Loamy range site, 16 to 24 inches precipitation; windbreak group 7; not in a woodland group)

Asotin-Spofford complex, 0 to 15 percent slopes (AnC).-This complex is on plateaus in areas where the annual precipitation is 16 to 20 inches. It is 75 percent Asotin silt loam, high rainfall, and 25 percent Spofford silt loam. The Spofford soil occurs as slick spots, or shallow saucerlike depressions, that are 10 to 30 feet in diameter and are intermingled with areas of Asotin soil.

The Asotin soil has a profile similar to that of Asotin silt loam, 7 to 25 percent slopes, except that the surface layer is very dark brown and is 3 to 6 inches thicker. The Spofford soil has the profile described as representative of the series.

This complex is used mainly for wheat, barley, alfalfa, and grass. The Spofford soil is cultivated along with adjoining areas of Asotin soil; it is easily distinguished from that soil by the poor plant growth. Uncultivated areas of this complex are used for range and for wildlife habitat. (Capability unit IVe-6; Loamy range site, 16 to 24 inches precipitation; windbreak group 7; not in a woodland group)

Athena Series

The Athena series consists of well-drained soils of the uplands. These soils formed under bunchgrass in wind-laid silt. Elevations range from 1,850 to 3,400 feet. Slopes are 0 to 65 percent. The annual precipitation is 16 to 20 inches, and the mean annual temperature is about 48° F. The frost-free season is 135 to 145 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 15 inches thick. The subsoil is brown and pale-brown silt loam that extends to a depth of about 40 inches. The substratum is pale-brown silt loam. that extends to bedrock, or to a depth of more than 60 inches. The soil is neutral in the surface layer and mildly alkaline to moderately alkaline below the surface layer.

Soils of the Athena series are used mainly for small grain, grass seed, hay, and pasture.

Athena silt loam, 7 to 25 percent slopes (AoD).-This soil is on uplands. Most areas are 10 to 80 acres in size.

Representative profile, 250 feet west and 60 feet south of the northeast corner of sec. 16, T. 12 N., R. 44 E.

Ap-0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; neutral; abrupt, smooth boundary.

A1-7 to 15 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (l0YR 2/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; neutral; clear, wavy boundary.

B21-15 to 26 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, medium, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; very thin clay films in some pores; mildly alkaline; gradual, wavy boundary.

B22-26 to 40 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak, medium, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; mildly alkaline; gradual, wavy boundary.

C-40 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; mildly alkaline.

The A horizon is as thin as 10 inches in places where the slope is convex and as thick as 17 inches in sheltered spots and depressions. Bedrock begins at a depth of more than 60 inches.

Included with this soil in mapping were small areas where the slope is more than 25 percent, areas where the slope is less than 7 percent, and areas where bedrock is at a depth of less than 60 inches. Also included (in secs. 16, 17, 20, and 21, T. 12 N., R. 44 E.) were five intermittent lakebeds that are ponded in winter and early in spring. The soils in the lakebeds have a clayey subsoil that begins at. a depth of about 2 feet.

Permeability is moderate, and roots penetrate to a depth of more than 60 inches. The soil holds about 12 inches of water that plants can use. Runoff is medium; most of it comes when the snow melts in spring and during rainstorms late in spring and in fall. The hazard of water erosion is moderate, and the hazard of wind erosion is slight.

This soil (fig. 3) is used mainly for wheat, barley, alfalfa, grass, and grass seed. (Capability unit IIIe-3;

Figure 3.-Rough cloddy tillage on Athena silt loam, 7 to 25 percent slopes. Seedbeds prepared this way greatly reduce the risk of erosion in winter. This area is in SW1/4 sec. 9, T. 13 N., R. 43 E.

windbreak group 4; not in a range site or woodland group)

Athena silt loam, 0 to 7 percent slopes (AoB).-This soil is on basalt plateaus. It is similar to Athena silt loam, 7 to 25 percent slopes, except for slope. The areas range from 10 to 160 acres in size. In most places the slope is 3 to 7 percent.

Included with this soil in mapping were small areas where the slope is more than 7 percent. Also included are areas where bedrock begins at a depth of less than 60 inches.

Runoff is slow, and the hazard of water erosion is slight.

This soil is used mainly for wheat, barley, grass seed, hay, and pasture. (Capability unit IIe-2; windbreak group 4; not in a range site or woodland group)

Athena silt loam, 25 to 40 percent slopes (AoE).-This soil is on the sides of drainageways leading from the basalt plateau. It is similar to Athena silt loam, 7 to 25 percent slopes, except for slope and the thickness of the surface layer. In this soil the surface layer is 7 to 14 inches thick. The areas range from 10 to 40 acres in size.

Included with this soil in mapping were small areas where the slope is more than 40 percent, areas where the slope is less than 25 percent, and areas where bedrock is at a depth of less than 60 inches.

Runoff is rapid, and the hazard of water erosion is severe. Snowdrifts are common in winter.

This soil is used mainly for wheat, barley, grass seed, hay, and pasture. (Capability unit IVe-4; Loamy range site, 16 to 24 inches precipitation; windbreak group 1; not in a woodland group)

Athena silt loam, 40 to 55 percent slopes (AoF).-This soil is on side slopes descending from basalt plateaus. It is similar to Athena silt loam, 7 to 25 percent slopes, except for slope and the thickness of the surface layer. In this soil the surface layer is 7 to 14 inches thick. The areas range from 10 to 120 acres in size.

Included with this soil in mapping were small areas where the slope is less than 40 percent. Also included were areas where bedrock is at a depth of less than 60 inches.

Runoff is very rapid, and the hazard of water erosion is very severe. In winter, snowdrifts are common along the upper rims of this soil.

This soil is used mainly for grazing. (Capability unit VIe-2; North Exposure range site, 16 to 20 inches precipitation; windbreak group 7; not in a woodland group)

Athena silt loam, calcareous substratum, 0 to 7 percent slopes (ApB).-This soil is on basalt plateaus. It is similar to Athena silt loam, 7 to 25 percent slopes, except that it is less sloping and is calcareous at a depth of 40 to 60 inches. The areas range from 10 to 160 acres in size. In most places the slope is 2 to 7 percent.

Included with this soil in mapping were small areas where the slope is more than 7 percent and areas where bedrock is at a depth of less than 60 inches. Also included

were a few small areas of Spofford silt loam, which occur as slick spots.

Runoff is slow, and the hazard of water erosion is slight. The soil holds 10 to 12 inches of water that plants can use.

This Athena soil is used mainly for wheat, barley, grass seed, hay, and pasture. (Capability unit IIe-2; windbreak group 4; not in a range site or woodland group)

Athena silt loam, calcareous substratum, 7 to 25 percent slopes (ApD).-This soil is on the sides of drainageways leading from the basalt plateau. It is similar to Athena silt loam, 7 to 25 percent slopes, except that it. is calcareous at a depth of 40 to 60 inches. The areas range from 10 to 200 acres in size.

Included with this soil in mapping were areas where the slope is less than 7 percent or more than 25 percent. Also included were areas that are not calcareous areas where bedrock is at a depth of less than 60 inches, and a few small areas of Spofford silt loam, which occur as slick spots.

This Athena soil holds 10 to 12 inches of water that plants can use. It is used mainly for wheat, barley, grass seed, hay, and pasture. (Capability unit IIIe-3; windbreak group 4; not in a range site or woodland group)

Athena silt loam, calcareous substratum, 25 to 40 percent slopes (ApE).-This soil is on the sides of drainageways leading from the basalt plateau. It is similar to Athena silt loam, 7 to 25 percent slopes, except that it is more sloping, it is calcareous at a depth of about 48 inches, and the surface layer is 8 to 14 inches thick. The areas range from 10 to 20 acres in size.

Included with this soil in mapping were small areas where the slope is more than 40 percent or less than 25 percent and areas where bedrock begins at a depth of less than 60 inches. Also included were areas that are not calcareous and small areas where erosion has exposed the calcareous substratum.

Runoff is rapid, and the hazard of water erosion is severe. The soil holds about 10 to 12 inches of water that plants can use.

This soil used mainly for wheat, barley grass seed, hay, and pasture. (Capability unit IVe-4; Loamy range site, 16 to 24 inches precipitation; windbreak group 7; not in a woodland group)

Athena silt loam, calcareous substratum, 40 to 65 percent slopes (ApF).-This soil is on the sides of drainageways leading from the basalt plateau. It is similar to Athena silt loam, 7 to 25 percent slopes, except that it is more sloping, it is calcareous at a depth of about 48 inches, and the surface layer is 8 to 14 inches thick. The areas range from 10 to 90 acres in size.

Included with soil in mapping were small areas where the slope is less than 40 percent, areas that are not calcareous, and areas where bedrock is at a depth of less than 60 inches.

Runoff is very rapid, and the hazard of water erosion is very severe. The soil holds 10 to 12 inches of water that plants can use. In winter, snowdrifts are common along the upper rims of this soil.

This soil is used mainly for grazing. (Capability unit VIe-2; North Exposure range site, 16 to 20 inches precipitation; windbreak group 7; not in a woodland group)

Athena silt loam, moderately shallow, 0 to 7 percent slopes (ArB).-This soil is on basalt plateaus. It is similar to Athena silt loam, 7 to 25 percent slopes, except that it is less sloping, the substratum is calcareous, and bedrock begins at a depth of 40 to 60 inches. The areas range from 10 to 30 acres in size. In most places the slope is 2 to 7 percent.

Included with this soil in mapping were small areas where the slope is more than 7 percent and areas where bedrock begins at a depth of less than 40 inches or more than 60 inches. Also included were areas that are not calcareous and a few small areas of Spofford silt loam, which occur as slickspots.

Runoff is slow, and the hazard of water erosion is slight. The soil holds about 8 to 12 inches of water that plants can use.

This Athena soil is used mainly for wheat, barley, grass seed, hay, and pasture. (Capability unit IIe-2; windbreak group 3 ; not in a range site or woodland group)

Athena silt loam, moderately shallow; 7 to 25 percent slopes (ArD).-This soil is on uplands. It is similar to Athena silt loam, 7 to 25 percent slopes, except that the substratum is calcareous and bedrock is at a depth of 40 to 60 inches. The areas range from 10 to 160 acres in size.

Included with this soil in mapping were small areas where the slope is less than 7 percent or more than 25 percent and areas where bedrock begins at a depth of less than 40 inches or more than 60 inches. Also included were areas that are not calcareous and a few small areas of Spofford silt loam, which occur as slickspots.

This Athena soil holds about 8 to 12 inches of water that plants can use. It is used mainly for wheat, barley, grass seed, hay, and pasture. (Capability unit IIIe-3 windbreak group 3; not in a range site or woodland group)

Athena silt loam, moderately shallow, 25 to 40 percent slopes (ArE).-This soil is on side slopes descending from basalt plateaus. It is similar to Athena silt loam, 7 to 25 percent slopes, except that it is more sloping, the substratum is calcareous, and bedrock begins at a depth of 40 to 60 inches. The areas range from 10 to 80 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent and areas where bedrock begins at a depth of less then 40 inches or more than 60 inches. Also included were areas that are not calcareous and a few areas where erosion has exposed the calcareous substratum.

Runoff is rapid, and the hazard of water erosion is severe. The soil holds about 8 to 10 inches of water that plants can use. Snowdrifts are common in winter.

This soil is used mainly for wheat, barley, grass seed, hay, and pasture. Farming is difficult, and there is a strong tendency for tillage operations to move soil material downhill. (Capability unit IVe-4; Loamy range site, 16 to 24 inches precipitation; windbreak group 7; not in a woodland group)

Athena-Lance silt loams, 10 to 40 percent slopes, eroded (AsE2).-This complex is about 65 percent Athena silt loam and about 35 percent Lance silt loam. The Athena soil occupies south slopes, and the Lance soil occupies narrow, severely eroded ridgetops, small rounded knobs, and steep, convex south slopes.

The Lance soil in this complex has the profile described as representative of the Lance series.

Runoff is medium to rapid; most of it comes from melting snow early in spring. The hazard of water erosion is moderate to severe.

This complex is used mainly for wheat, barley, hay, and grass. (Capability unit IVe-4; windbreak group 7; not in a range site or woodland group)

Athena-Spofford silt loams, 0 to 15 percent slopes (AtC).-This complex is on basalt plateaus. It is about 75 percent Athena silt loam and about 25 percent Spofford silt loam. The Spofford soil occurs as slick spots, roughly circular and 10 to 30 feet in diameter, that are intermingled with areas of the Athena soil.

Runoff is medium; most of it comes from melting snow and early spring rains. The hazard of water erosion is moderate.

This complex is used mainly for wheat and barley. It is also used for grass seed, hay, and pasture. (Capability unit IVe-5 ; windbreak group 7 ; not in a range site or woodland group)

Athena-Spofford silt loams, 15 to 25 percent slopes (AtD).-This complex is on side slopes that descend from basalt plateaus. It is about 75 percent Athena silt loam and about 25 percent Spofford silt loam. The Spofford soil occurs as small, elongated areas that are along shallow drainageways and are intermingled with large areas of the Athena soil.

Included in mapping were areas of a soil that is moderately shallow to bedrock.

Runoff is rapid, and the hazard of erosion is severe. Runoff from the Spofford soil frequently causes severe rilling on the Athena soil.

This complex is used mainly for wheat, barley, hay, and pasture. Areas that support native bunchgrass are used for grazing and for wildlife habitat. (Capability unit IVe-5; windbreak group 7; not in a range site or woodland group)

Bakeoven Series

The Bakeoven series consists of well-drained or somewhat excessively drained soils of the uplands. These soils formed under sagebrush and bunchgrass in a mixture of wind-laid material and material weathered from basalt. Bedrock begins at a depth of 4 to 12 inches. Elevations range from 600 to 3,000 feet. Slopes are 0 to 50 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

In a representative profile the surface layer is grayish--brown extremely stony silt loam about 4 inches thick. The subsoil is brown very cobbly and gravelly heavy silt loam. Basalt bedrock begins at a depth of about 7 inches. The soil is neutral to mildly alkaline.

Soils of the Bakeoven series are used for range. In this survey area they are mapped only in a complex with Lickskillet soils.

Representative profile of Bakeoven extremely stony silt loam in an area of Lickskillet-Bakeoven complex, 10 to 50 percent slopes, 1,200 feet east and 400 feet north of the southwest corner of sec. 35, T. 13 N., R. 40 E.

A1-0 to 4 inches, grayish-brown (10YR 5/2) extremely stony silt loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure breaking to weak, fine, granular; slightly hard, friable, slightly sticky. and slightly plastic; many roots; many fine and medium pores; about 80 percent by volume is gravel, cobblestones, and stones; neutral; abrupt, wavy boundary.

B2-4 to 7 inches, brown (10YR 6/3) very cobbly and gravelly silt loam, dark brown (10YR 3/3) moist; moderate, fine, subangular blocky structure; hard, friable, sticky and plastic; many roots; about 75 to 85 percent by volume is basalt fragments; neutral; abrupt, wavy boundary.

R-7 inches, basalt bedrock; material from the B2 horizon in fractures.

The depth to bedrock ranges from 4 to 12 inches.

Permeability is moderate, and roots penetrate to bedrock. The soils hold about 1 inch of water that plants can use. Runoff is very rapid, and the hazard of erosion is severe.

Benge Series

The Benge series consists of well-drained soils on terraces and terrace breaks. These soils formed under bunchgrass in glacial outwash mixed with wind-laid silt in the upper part. Elevations are 600 to 800 feet. Slopes are 15 to 50 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 52° F. The frost-free season is 135 to 150 days.

In a representative profile the surface layer is dark grayish-brown, slightly hard gravelly silt loam about 12 inches thick. The subsoil is brown gravelly sandy loam that extends to a depth of about 20 inches. The substratum is brown gravelly sandy loam that extends to clean, waterworn gravel and sand. The soil is neutral in the surface layer and mildly alkaline below the surface layer.

Soils of the Benge series are used mainly for range.

Benge gravelly silt loam, 15 to 50 percent slopes (BeF).-This soil is on remnants of terraces along the Snake River.

Representative profile, 550 feet north and 400 feet east of the southwest corner of sec. 18, T. 14 N., R 43 E.

A11-0 to 8 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; 20 percent by volume is gravel; neutral; clear, wavy boundary.

A12-6 to 12 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; 30 percent by volume is gravel; neutral; clear, wavy boundary.

B2-12 to 20 inches, brown (10YR 4/3) gravelly sandy loam, dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky and nonplastic ; common roots; common very fine pores; 45 percent by volume is gravel; mildly alkaline; clear, wavy boundary.

C1-20 to 28 inches, brown (IOYR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; massive; soft, friable, nonsticky and nonplastic ; few roots; 45 percent by volume is gravel; mildly alkaline; gradual, wavy boundary.

IIC2-28 to 80 inches, waterworn gravel and sand.

The B horizon is gravelly sandy loam, gravelly loam, or gravelly silt loam. The depth to waterworn gravel ranges from 23 to 37 inches.

Included with this soil in mapping were small areas where the slope is less than 15 percent or more than 50 percent and areas where gravel begins at a depth of less than 23 inches or more than 37 inches. Also included were areas where the surface layer is not gravelly.

Permeability is moderately rapid, and roots penetrate to clean gravel and sand. The soil holds about 4 to 6 inches of water that plants can use. Runoff is medium to rapid. The hazard of water erosion is moderate to severe, but the hazard of wind erosion is only slight.

This soil is used mainly for grazing. (Capability unit VIe-1; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Chard Series

The Chard series consists of well-drained soils on terraces. These soils formed under bunchgrass in a mixture of wind-laid silt and glacial outwash. Elevations range from 600 to 1,400 feet. Slopes are 0 to 40 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

In a representative profile the surface layer is dark grayish-brown silt loam and loam about 12 inches thick. The subsoil is brown loam that extends to a depth of about 25 inches. The substratum is brown and light brownish-gray fine sandy loam that extends to a depth of about 65 inches. The soil is neutral in the surface layer and subsoil and is moderately alkaline to strongly alkaline below.

Soils of the Chard series are used mainly for wheat, barley, hay, and pasture. A few areas are used for orchards.

Chard silt loam, 7 to 25 percent slopes (CdD).-This soil is on dissected terraces. The areas are 10 to 120 acres in size.

Representative profile, 1,280 feet north and 520 feet east of the southwest corner of sec. 28, T. 13 N., R. 40 E.

A11-0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, thin, platy structure; soft, very friable, nonsticky and nonplastic ; many roots; 1 percent is fine gravel; neutral; abrupt, smooth boundary.

A12-4 to 12 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic ; many roots; common fine pores; 8 to 10 percent is coarse and very coarse sand; neutral; gradual, smooth boundary.

B2-12 to 25 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure; slightly hard, very friable, nonsticky and nonplastic; common roots; 9 to 12 percent is coarse and very coarse sand; neutral; gradual, wavy boundary.

C1-25 to 34 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic ; common roots; 12 to 15 percent is coarse and very coarse sand; moderately alkaline; clear, wavy boundary.

C2ca-34 to 65 inches, light brownish-gray (10YR 6/2) fine sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic ; common roots; 12 to 15 percent is coarse and very coarse sand; strong effervescence; strongly alkaline.

The amount of fine gravel and coarse sand ranges from 1 to 10 percent in the A horizon and increases with depth.

The B horizon is very fine sandy loam or loam in texture.

The depth to calcareous material ranges from 24 to 38 inches. Lenses of fine gravel are common in the lower horizons.

Included with this soil in mapping were small areas where the slope is less than 7 percent or more than 25 percent and areas where bedrock begins at a depth of less than 60 inches. Also included were small eroded areas where the surface layer is fine sandy loam and areas where the surface layer is calcareous.

Permeability is moderately rapid, and roots penetrate to a depth of more than 60 inches. The soil holds 8 to 10 inches of water that plants can use. Runoff is medium; most of it comes when the snow melts in winter and early spring and from spring rains and summer thunderstorms. The hazards of water erosion and wind erosion are moderate.

This soil is used mainly for wheat, barley, alfalfa, and grass. Irrigated crops are grown in a few areas along the Snake River and the mayor streams. (Capability unit IIIe-1; windbreak group 3; not in a range site or woodland group)

Chard silt loam, 0 to 7 percent slopes (CdB).-This soil is on dissected terraces. It is similar to Chard silt loam, 7 to 25 percent slopes, except for slope. The areas range from 10 to 70 acres in size. In most places the slope is 3 to 7 percent.

Included with this soil in mapping were small areas where the slope is more than 7 percent and areas where bedrock begins at a depth of less than 60 inches. Also included were eroded areas where the surface layer is fine sandy loam.

Runoff is slow. The hazards of water erosion and wind erosion are slight.

This soil is used mainly for wheat, barley, alfalfa, and grass. Irrigated crops are gown in a few areas on terraces along the Snake River and the major streams. (Capability unit IIe-1; windbreak group 3; not in a range site or woodland group)

Chard silt loam, 25 to 40 percent slopes (CdE).-This soil is on side slopes descending from dissected terraces. It is similar to Chard silt loam, 7 to 25 percent slopes, except for slope and the thickness of the surface layer. In this soil the surface layer is 9 to 12 inches thick. The areas range from 10 to 320 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent and areas where bedrock begins at a depth of less than 60 inches. Also included were eroded areas where the surface layer is fine sandy loam and areas where the surface layer is calcareous.

Runoff is rapid, and the hazard of water erosion is severe.

This soil is used mainly for grazing. Farming is difficult, and there is a strong tendency for tillage operations to move soil material downhill. (Capability unit IVe-1; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Chard silt loam, moderately shallow, 7 to 25 percent slopes (CeD).-This soil is on dissected terraces. It is similar to Chard silt loam, 7 to 25 percent slopes, except that the depth to bedrock is 40 to 60 inches. The areas range from 10 to 20 acres in size.

Included with this soil in mapping were small areas where the slope is less than 7 percent or more than 25

percent and areas where bedrock begins at a depth of less than 40 inches or more than 60 inches. Also included were a few areas that are gravelly or sandy, or both, and are calcareous in the surface layer in places.

This soil holds 7 to 10 inches of water that plants can use.

This soil is used mainly for wheat, barley, and pasture. (Capability unit IIIe-1; windbreak group 2; not in a range site or woodland group)

Chard very fine sandy loam, 7 to 25 percent slopes, eroded (ChD2).-This soil is on dissected terraces. It is similar to Chard silt loam, 7 to 25 percent slopes, except for the texture of the surface layer and substratum. In this soil the substratum is loamy sand or sand. The areas range from 10 to 60 acres in size.

Included with this soil in mapping were small areas where the slope is less than 7 percent or more than 25 percent and uneroded areas where the surface layer is silt loam. Also included were areas of fine sandy loam where the surface layer is calcareous.

Runoff is slow to medium. This soil holds about 6 to 8 inches of water that plants can use. The hazard of water erosion is moderate, and the hazard of wind erosion is severe.

This soil is used mainly for grazing. (Capability unit IVe-2; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Chard very fine sandy loam, 25 to 40. percent slopes, eroded (ChE2).-This soil is on side slopes descending from dissected terraces. It is similar to Chard silt loam, 7 to 25 percent slopes, except for slope and the texture of the surface layer and substratum. In this soil the substratum is loamy sand or sand. The areas range from 10 to 80 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent and uneroded areas where the surface layer is silt loam. Also included were areas of fine sandy loam where the surface layer is calcareous.

Runoff is medium to rapid. The soil holds about 6 to 8 inches of water that plants can use. The hazards of water erosion and wind erosion are severe.

This soil is used mainly for grazing. (Capability unit VIe-1; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Gwin Series

The Gwin series consists of well-drained, extremely stony soils in canyons of major drainageways. These soils formed under bunchgrass in a mixture of wind-laid silt and material weathered from basalt. Basalt bedrock begins at a depth of 12 to 20 inches. Elevations range from 1,900 to 4,500 feet. Slopes are 10 to 50 percent. The annual precipitation is 16 to 24 inches, and the mean annual temperature is about 48° F. The frost-free season is 120 to 140 days.

In a representative profile the surface layer is dark grayish-brown, slightly hard extremely stony silt loam about 5 inches thick. The subsoil is dark grayish-brown and brown, hard very cobbly silty clay loam that is about 9 inches thick and extends to basalt bedrock. The soil is mildly alkaline.

Soils of the Gwin series are used mainly for range.

Gwin extremely stony silt loam, 10 to 50 percent slopes (GnF).-This soil is in canyons of major drainageways.

Representative profile, 600 feet south and 2,800 feet west of the northeast corner of sec. 15, T. 10 N., R. 42 E.

A1-0 to 5 inches, dark grayish-brown (10YR 4/2) extremely stony silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; common very fine pores; about 60 percent is cobblestones, gravel, and stones; mildly alkaline; clear, wavy boundary.

B21t-5 to 9 inches, dark grayish-brown (10YR 4/2) very cobbly silty clay loam, very dark brown (10YR 2/2) moist; moderate, very fine and fine; subangular blocky structure; hard, firm, sticky and plastic; common roots; common very fine pores; thin patchy cutans, or clay films, in pores and on ped surfaces; about 70 percent is cobblestones and gravel; mildly alkaline; clear, wavy boundary.

B22t-9 to 12 inches, brown (10YR 5/8) very cobbly silty clay loam, dark brown (10YR 8/8) moist; moderate, very fine and fine, subangular blocky structure ; hard, firm, sticky and plastic; common roots; many very fine pores; thin patchy cutans, or clay films, in pores and on ped surfaces; about 85 percent is cobblestones and gravel; mildly alkaline; abrupt, wavy boundary.

B3-12 to 14 inches, broken and fractured basalt; some material from the B22t horizon in fractures; few roots.

IIR-14 inches, basalt bedrock.

Bedrock begins at a depth of 12 to 20 inches. Stones cover 10 to 20 percent of the surface. Rock crops out in 3 to 10 percent of the acreage.

Included with this soil in mapping were small areas where the slope is less than 10 percent or more than 50 percent, areas where bedrock is at a depth of less than 12 inches or more than 20 inches, and areas where the soil is not stony.

Permeability is moderately slow, and roots penetrate to bedrock. The soil holds about 2 inches of water that plants can use. Runoff is rapid to very rapid; most of it comes from melting snow in winter and early in spring and during rainstorms in spring. The hazard of water erosion is moderate to very severe.

This soil is used mainly for grazing. It is not suitable for cultivation. (Capability unit VIIs-2; Shallow range site, 16 to 24 inches precipitation; windbreak group 7; not in a woodland group)

Gwin-Rock outcrop complex, 10 to 50 percent slopes (GrF).-This complex is on canyon walls. It is about 60 percent Gwin extremely stony silt loam and about 40 percent Rock outcrop. The Rock outcrop part of the complex is scattered throughout the areas of Gwin soil. The outcrops consist of cliffs, ledges, escarpments, and exposed basalt.

Little, if any, of the precipitation penetrates the outcrops, and the shallow Gwin soil is quickly saturated by melting snow and spring rains. Consequently, runoff is very rapid and is an important part of the peak streamflow. The hazard of water erosion is very severe.

This complex is used mainly for grazing. (Capability unit VIIs-2; Gwin part in Shallow range site, 16 to 24 inches precipitation; Rock outcrop part not in a range site; both parts in windbreak group 7; neither part in a woodland group)

Henningsen Series

The Henningsen series consists of somewhat poorly drained soils on bottom lands along streams. These soils formed under grass in alluvium. Elevations range from 600 to 3,500 feet. Slopes are 0 to 5 percent. The annual precipitation is 12 to 20 inches, and the mean annual temperature is about 50° F. The frost-free season is 120 to 155 days.

In a representative profile the surface layer is dark grayish-brown cobbly silt loam about 6 inches thick. The substratum is grayish-brown very cobbly loamy coarse sand that extends to clean gravel and cobblestones at a depth of about 24 inches. The soil is mildly alkaline.

Soils of the Henningsen series are used mainly for recreation and wildlife habitat.

Henningsen cobbly silt loam (He).-This soil is along intermittent and perennial streams. Dams (fig. 4) have been constructed in a few places to catch silt carried by runoff.

Representative profile, 120 feet west and 1,500 feet north of the southeast corner of see. 17, T.11 N., R. 44 E.

A1-0 to 6 inches, dark grayish-brown (10YR 4/2) cobbly silt loam, very dark brown (10YR 2/2) moist; weak, thick, platy structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; 26 percent by volume is cobblestones and gravel; mildly alkaline; clear, wavy boundary.

C1-6 to 24 inches, grayish-brown (10YR 6/2) very cobbly loamy coarse sand, very dark grayish brown (10YR, 8/2) moist; massive; soft, nonsticky and nonplastic ; common roots; 55 percent by volume is cobblestones and gravel; mildly alkaline; gradual, wavy boundary.

C2-24 to 60 inches, waterworn basalt cobblestones, gravel, and stones.

The depth to clean basalt gravel, cobblestones, and atones, ranges from 20 to 30 inches.

Figure 4.-Small silt dams constructed on Henningsen cobbly silt loam. When enough silt has been deposited, grass will be seeded and the soil used for pasture. The very steep hill in the background is part of Lickskillet-Rock outcrop complex, 0 to 50 percent slopes. This area is in SW1/4 sec 16, T. 11 N., R. 44 E.

Included with this soil in mapping were small areas where the surface layer is gravelly and areas of streamwash along waterways.

Permeability is very rapid below the surface layer, and roots penetrate to the gravel, cobblestones, and stones. The soil holds about 3 inches of water that plants can use. The water table is at a depth of 4 to 6 feet during spring runoff. Runoff is slow. The hazards of water erosion and wind erosion are slight.

This soil is used mainly for recreation and wildlife habitat. (Capability unit VIIw-1; windbreak group 7; not in a range site or woodland group)

Hermiston Series

The Hermiston series consists of well-drained, nearly level soils of terraces and bottom lands. These soils formed under bunchgrass in alluvium mixed with wind-laid deposits and some volcanic ash. Elevations range from 600 to 2,500 feet. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 150 days.

In a representative profile the surface layer is grayishbrown silt loam about 25 inches thick. The underlying material is pale-brown, calcareous silt loam. The soil is mildly alkaline in the surface layer and strongly alkaline below the surface layer.

Soils of the Hermiston series are used mainly for small grain, hay, pasture, and orchards.

Hermiston silt loam (Hr).-This soil is along stream channels. Slopes range from 0 to 3 percent.

Representative profile, 1,920 feet west and 820 feet south of the northeast corner of sec. 36, T.12 N., R. 40 E.

Ap-0 to 8 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; mildly alkaline; abrupt, wavy boundary.

A1-8 to 25 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; many roots; many very fine pores; mildly alkaline ; clear, wavy boundary.

C1-25 to 33 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine and common fine pores; free lime in old root channels; violent effervescence; strongly alkaline; clear, wavy boundary.

C2-33 to 40 inches, pale-brown (10YR 6/3) light silt loam, dark brown (10YR 3/3) moist; massive; soft, friable, slightly sticky and slightly plastic; few roots; many very fine pores; strongly alkaline; clear, wavy boundary.

C3-40 to 60 inches, pale-brown (10YR E/3) light silt loam, dark brown (10YR 3/3) moist; massive; soft, friable, slightly sticky and slightly plastic; few roots; many very fine pores; violent effervescence; strongly alkaline.

The A horizon ranges from 22 to 34 inches in thickness.

Included with this soil in mapping were small area, that are free of lime and small areas where the surface layer is volcanic ash. Also included were scattered areas of alkali soil, or slickspots.

Permeability is moderate, and roots penetrate to a depth of more than 60 inches. The soil holds about 12 inches of water that plants can use. Runoff is slow. The hazards of water erosion and wind erosion are slight. Streambanks need protection from cutting.

This soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IIc-1; windbreak group 3; not in a range site or woodland group)

Klicker Series

The Klicker series consists of well-drained soils of the uplands. These soils formed under ponderosa pine, Douglas-fir, shrubs, and grass in material weathered from basalt. Basalt is at a depth of 20 to 40 inches. Elevations range from 3,000 to 4,500 feet. Slopes are 5 to 50 percent. The annual precipitation is 22 to 30 inches, and the mean annual temperature is about 45° F. The frost-free season is 100 to 120 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 3 inches thick. The subsoil is brown silty clay loam about 26 inches thick. Bedrock is at a depth of about 29 inches. The soil is neutral to slightly acid.

Soils of the Klicker series are used mainly for woodland, recreation, wildlife habitat, and woodland grazing.

Klicker-Rock outcrop complex, 5 to 25 percent slopes (KrD).-This complex is on canyon walls in a mountainous area. It is about 85 percent Klicker silt loam and about 15 percent Rock outcrop. The Rock outcrop part of the complex is scattered throughout the areas of Klicker soil. The outcrops consist of small areas of basalt ledges and cliffs.

Representative profile, 3,100 feet east and 400 feet north of the southwest corner of sec. 33, T.10 N., R. 42 E.

01&02-1 inch to 0, needles, twigs, bark, and wood fragments.

A1-0 to 3 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; neutral; abrupt, smooth boundary.

B21t-3 to 20 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 3/4) moist; weak, medium and coarse, prismatic structure breaking to weak, medium and coarse, subangular blocky; hard, firm, sticky and plastic; many roots; 10 percent is angular. basalt gravel; common very fine pores; very thin clay films in some pores; neutral; clear, wavy boundary.

B22t-20 to 29 inches, brown (7.5YR 5/4) very cobbly silty clay loam, dark brown (7.5YR 3/4) moist; massive; hard, firm, sticky and plastic; common roots; 70 percent is cobblestone-size fragments of basalt; common very fine pores; very thin clay films in some pores; slightly acid.

R-29 inches, basalt bedrock.

The thickness of the combined A and B horizons and the depth to basalt range from 20 to 40 inches. In places basalt fragments make up as much as 15 percent of the A horizon. The B horizon is dominantly silty clay loam in texture, but it ranges from light silt loam to silty clay and is 10 to 70 percent angular gravel, cobblestones, and stones.

Permeability is moderately slow in the Klicker soil, and roots penetrate to bedrock. The soil holds 4 to 7 inches of water that plants can use. Runoff is medium; most of it comes from melting snow and early spring rains. The hazard of erosion is moderate.

This complex is used mainly for woodland, wildlife habitat, and woodland grazing. (Capability unit VIIs-3; woodland group 4d; neither part in a range site or windbreak group)

Klicker-Rock outcrop complex, 25 to 50 percent slopes (KrF).-This complex is on canyon walls. It is about 85 percent Klicker silt loam and about 15 percent Rock outcrop.

Runoff is rapid, and the hazard of erosion is severe.

This complex is used mainly for woodland, recreation, wildlife habitat, and woodland grazing. (Capability unit VIIs-3; woodland group 4d; neither part in a range site or windbreak group)

Lance Series

The Lance series consists of well-drained soils of narrow ridgetops, knobs, and short upland slopes. These soils formed under bunchgrass in calcareous wind-laid silt. Elevations range from 1,900 to 2,800 feet. Slopes are 10 to 40 percent. The annual precipitation is 16 to 20 inches, and the mean annual temperature is about 49° F. The frost-free season is 135 to 145 days.

In a representative profile the surface layer is light brownish-gray, calcareous silt loam about 8 inches thick. Below this is light-gray, calcareous silt loam that extends to a depth of about 26 inches. This is underlain by pale-brown, slightly calcareous silt loam that extends to a depth of 60 inches. The layers of soil below the surface layer are weakly cemented with lime and silica. The soil is moderately alkaline to a depth of 26 inches and is strongly alkaline below.

Soils of the Lance series are used mainly for wheat, barley, hay, and pasture. In this survey area they are mapped only in complexes with Athena and Oliphant soils.

Representative profile of Lance silt loam, eroded, in an area of Athena-Lance silt looms, 10 to 40 percent slopes, eroded, 120 feet north and 160 feet east of the southwest corner of sec. 19, T. 12 N., R. 44 E.

Ap-0 to 8 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; 15 percent is caliche fragments; violent effervescence; moderately alkaline; abrupt, smooth boundary.

C1sica-8 to 17 inches, light-gray (10YR 7/2) heavy silt loam, brown (10YR 5/3) moist; moderate, medium, subangular blocky structure; hard, firm, slightly plastic; few very fine roots; common very fine pores; free lime in pores; violent effervescence; moderately alkaline; clear wavy boundary.

C2sica-17 to 26 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; weak, medium, subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; common very fine pores; free line in pores; violent effervescence; moderately alkaline; clear, wavy boundary.

C3sica-26 to 47 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive ; very hard, firm, slightly sticky and slightly plastic; Pew very fine roots; common very fine pores; common extremely hard durinodes; strong effervescence; strongly alkaline; gradual, wavy boundary.

C4sica-47 to 60 inches, pale-brown (10YR 6/3) heavy silt loam, brown (10YR 4/3) moist; hard, firm, slightly sticky and slightly plastic; common very fine pores; slight effervescence; strongly alkaline.

The Ap horizon ranges from brown (10YR 5/3) to very pale brown (10YR 7/3) in color.

Permeability is moderately slow. Plant roots penetrate to a depth of about 47 inches but are few in number below the uppermost few inches of the soil. The soils hold 5 to 7 inches of water that plants can use. Runoff is medium to rapid; most of it comes from melting snow early in spring. The hazard of water erosion is moderate to severe.

Larkin Series

The Larkin series consists of well-drained soils of the uplands. These soils formed under trees, grass, and shrubs in wind-laid silt. Elevations range from 3,000 to 4,500 feet. Slopes are 0 to 60 percent. The annual precipitation is 22 to 30 inches, and the mean annual temperature is 46° F. The frost-free season is 100 to 120 days.

In a representative profile the surface layer is silt loam, about 12 inches thick, that is dark grayish brown in the upper part and grayish brown in the lower part. The subsoil, between depths of 12 and 39 inches, is brown silty clay loam. Below this is light yellowish-brown sandy clay loam that overlies basalt bedrock or tuff at a depth of about 46 inches. The soil is neutral throughout the profile.

Soils of the Larkin series are used for woodland, recreation, wildlife habitat, and woodland grazing. A few small areas are farmed; crops are mainly grass, wheat, and barley.

Larkin silt loam, 0 to 15 percent slopes (LaC).-This soil is on uplands. The areas are 20 to 140 acres in size.

Representative profile, 1,640 feet south and 2,220 feet west of the northeast corner of sec. 1, T. 9 N., R. 42 E.

01&02-1 inch to 0, leaves, bark, twigs, moss, and wood fragments.

A1-0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; soft, friable, slightly sticky and slightly plastic; common roots; neutral; clear, smooth boundary.

A3-6 to 12 inches, grayish-brown (10YR 6/2) silt loam, very dark grayish-brown (10YR 3/2) moist; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; thin clay films in larger pores; neutral; clear, wavy boundary.

B21t-12 to 23 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure breaking to moderate, fine, subangular blocky; hard, firm, sticky and plastic; common roots; many very fine pores; thin clay films on ped surfaces; neutral; gradual, wavy boundary.

B22t-23 to 39 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; strong, fine, subangular blocky structure; hard, firm, sticky and plastic; few roots; many very fine pores; thin clay films on all ped surfaces; neutral; abrupt, wavy boundary.

B3-39 to 46 inches, light yellowish-brown (10YR 6/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; hard, firm, sticky and plastic; few roots; common very fine pores; neutral; abrupt, wavy boundary.

IIR-46 inches, basalt bedrock or tuff.

The depth to bedrock ranges from 40 to 55 inches.

Included with this soil in mapping were small areas where the slope is more than 15 percent, areas where bedrock is at a depth of less than 40 inches or more than 55 inches, and areas where the surface layer is mostly volcanic ash.

Permeability is moderately slow, and roots penetrate to bedrock. The soil holds 8 to 10 inches of water that plants can use. Runoff is slow to medium; most of it comes from melting snow in spring and during rainstorms late in spring and in fall. The hazard of water erosion is slight to moderate, and the hazard of wind erosion is slight.

This soil is used mainly for wheat, barley, alfalfa, clover, grass, and grass seed. It is also used for woodland, recreation, and wildlife habitat. (Capability unit IIIe-6; woodland group 3o; not in a range site or windbreak group)

Larkin silt loam, 15 to 25 percent slopes.(LaD).-This soil is on side slopes descending from the basalt plateau. It is similar to Larkin silt loam, 0 to 15 percent slopes, except for slope. The areas range from 10 to 160 acres in size.

Included with this soil in mapping were small areas where the slope is less than 15 percent or more than 25 percent, areas where bedrock is at a depth of less than 40 inches or more than 55 inches, and areas where the surface layer is mostly volcanic ash.

Runoff is medium to rapid, and the hazard of water erosion is moderate to severe.

This soil is used mainly for woodland, recreation, and wildlife habitat. Snow tends to drift on this soil. (Capability unit IVe-8 ; woodland group 3o; not in a range site or windbreak group)

Larkin silt loam, 25 to 40 percent slopes (LaE).-This soil is on side slopes descending from the basalt plateau. It is similar to Larkin silt loam, 0 to 15 percent slopes, except for slope. The areas range from 20 to 200 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent, areas where bedrock is at a depth of less than 40 inches or more than 55 inches, and areas where the surface layer is mostly volcanic ash.

Runoff is rapid, and the hazard of water erosion is severe.

This soil is used mainly for woodland, recreation, and wildlife habitat. (Capability unit VIe-3; woodland group 2r; not in a range site or windbreak group)

Larkin silt loam, 40 to 60 percent slopes (LaF).-This soil is an side slopes descending from the basalt plateau. It is similar to Larkin silt loam, 0 to 15 percent slopes, except for slope. The areas range from 20 to 50 acres in size.

Included with this soil in mapping were small areas where the slope is less than 40 percent, areas where bedrock is at a depth of less than 40 inches or more than 55 inches, and areas where the surface layer is mostly volcanic ash.

Runoff is very rapid, and the hazard of water erosion is very severe.

This soil is used mainly for woodland, recreation, and wildlife habitat. (Capability unit VIe-3 ; woodland group 2r; not in a range site or windbreak group)

Lickskillet Series

The Lickskillet series consists of well-drained soils of the uplands. These soils formed under bunchgrass and rabbitbrush in a mixture of wind-laid silty material and material weathered from basalt. Basalt bedrock is at a depth of 10 to 20 inches. Elevations range from 600 to 3,000 feet. Slopes are 10 to 50 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

In a representative profile the surface layer is dark grayish-brown extremely stony silt loam about 10 inches thick. The subsoil is brown very cobbly and gravelly silt loam that extends to a depth of about 19 inches. Basalt bedrock begins at a depth of 19 inches. The soil is neutral in the surface layer and moderately alkaline in the lower part of the subsoil.

Soils of the Lickskillet series are used mainly for range.

Lickskillet extremely stony loam, 10 to 50 percent slopes (LcF).-This soil is on the sides of the basalt plateau.

Representative profile, 2,560 feet south and 1,160 feet west of the northeast corner of sec. 16, T. 12 N., R. 40 E.

A1-0 to 10 inches, dark grayish-brown (10YR 4/2) extremely stony silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; about 60 percent cobblestones, gravel, and stones; neutral; clear, wavy boundary.

B1-10 to 13 inches, brown (10YR 5/3) very cobbly and gravelly silt loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many roots; about 70 percent cobblestones and gravel; mildly alkaline; abrupt, wavy boundary.

B2ca-13 to 19 inches, brown (10YR 5/3) , broken and fractured basalt that contains free lime and silt loam material, dark brown (10YR 3/3) moist; Pew roots; 80 percent basalt fragments; violent effervescence; moderately alkaline; abrupt, smooth boundary.

IIR-19 inches, basalt bedrock.

The depth to bedrock ranges from 10 to 20 inches. Stones cover 10 to 20 percent of the surface.

Included with this soil in mapping were small areas where the slope is less than 10 percent, areas where bedrock is at a depth of less than 10 inches or more than 20 inches, and areas of nonstony soil.

Permeability is moderate, and roots penetrate to bedrock. The soil holds about 2 inches of water that plants can use. Runoff is rapid to very rapid; most of it comes when snow melts rapidly in winter and early in siring and during spring rains. The hazard of water erosion is severe to very severe, but the hazard of wind erosion is only slight.

This soil is used mainly for grazing. (Capability unit VIIs-1; Shallow range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Lickskillet-Bakeoven complex, 10 to 50 percent slopes (LkF).-This complex is on canyon walls of a dissected basalt plateau. It is about 50 percent Lickskillet extremely stony silt loam, 35 percent Bakeoven extremely stony silt loam, and about 15 percent included small areas of Anders silt loam and rock outcrops. The Lickskillet and Anders soils occur as hummocks separated by valleys of shallow Bakeoven soils and rock outcrops.

Runoff is very rapid, and the hazard of water erosion is severe.

This complex is used for grazing (fig. 5). (Capability unit VIIs-1; Lickskillet part in Shallow range site, 12 to 16 inches precipitation; Bakeoven part in Very Shallow range site, 12 to 16 inches precipitation; both parts in windbreak group 7; neither part in a woodland group)

Figure 5.-Spring development on Lickskillet-Bakeoven complex, 10 to 50 percent slopes. Both livestock and wildlife make use of the spring. This area is in SW1/4 sec. 30, T. 14 N., R. 42 E.

Lickskillet-Rock outcrop complex, 0 to 50 percent slopes (LlF).-This complex is on the sides of the basalt plateau. It is about 50 to 70 percent Lickskillet extremely stony silt loam and 30 to 50 percent basalt rock outcrops. The outcrops occur as small ledges, cliffs, or escarpments intermingled with areas of the Lickskillet soil.

This complex is used mainly for grazing. (Capability unit VIIs-1; Lickskillet part in Shallow range site, 12 to 16 inches precipitation; Rock outcrop part not in a range site; both parts in windbreak group 7; neither part in a woodland group)

Linville Series

The Linville series consists of well-drained soils of the uplands. These soils formed under grass and shrubs in a mixture of wind-laid silt, material weathered from basalt, and volcanic ash. Elevations range from 1,100 to 3,400 feet. Slopes are 40 to 65 percent. The annual precipitation is 20 inches, and the mean annual temperature is about 48° F. The frost-free season is 120 to 140 days.

In a representative profile the surface layer is dark grayish-brown silt loam and cobbly silt loam about 30 inches thick. The subsoil is brown and pale-brown cobbly heavy silt loam that extends to a depth of more than 60 inches: The soil is neutral to moderately alkaline.

Soils of the Linville series are used mainly for range.

Linville silt loam, 40 to 65 percent slopes (LnF).-This soil is on north- and east-facing slopes in canyons of the basalt plateau.

Representative profile, 920 feet west and 350 feet south of the northeast corner of sec. 2, T. 13 N., R. 42 E.

A11-0 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; common very fine pores; few scattered angular basalt pebbles; moderately alkaline; gradual, wavy boundary.

A12-12 to 25 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, medium, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many roots:

few medium and common very fine pores; few scattered angular basalt pebbles; neutral; clear, wavy boundary.

A13-25 to 30 inches, dark grayish-brown (10YR 4/2) cobbly silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; few coarse, few medium, and common very fine pores; 2 percent angular basalt cobblestones and gravel; mildly alkaline; abrupt, wavy boundary.

B21-30 to 43 inches, brown (10YR 5/3) cobbly heavy silt loam, dark grayish brown (10YR 4/2) moist; moderate, coarse, prismatic structure; hard, friable, sticky and plastic; common roots; few very coarse, many medium, and many very fine pores; clay films in pores; thin patchy siliceous coatings on ped Surfaces; mildly alkaline ; gradual, wavy boundary.

B22-43 to 54 inches, pale-brown (10YR 6/3) cobbly heavy silt loam, brown (10YR 4/3) moist; moderate, medium, prismatic structure; hard, friable, sticky and plastic; common roots; few very coarse, many medium, and many very fine pores; clay films in pores; thin patchy siliceous coatings on ped surfaces; mildly alkaline; gradual, wavy boundary.

B23-54 to 63 inches, pale-brown (10YR 6/3) cobbly heavy silt loam, dark brown (10YR 4/3) moist; massive; hard, friable, sticky and plastic; common roots; few medium and many very fine pores; clay films in pores; thin siliceous coatings on ped surfaces; mildly alkaline.

Included with this soil in mapping were small areas where the slope is less than 40 percent, areas where basalt bedrock begins at a depth of less than 60 inches, and small areas where bedrock crops out. In addition, in about one-third of the acreage the subsoil lacks a noticeable increase in clay content.

Permeability is moderate, and roots penetrate to a depth of more than 60 inches. The soil holds 10 to 12 inches of water that plants can use. Runoff is very rapid; most of it comes when the snow melts rapidly in winter and early in spring and during rainstorms in spring. The hazard of water erosion is very severe.

This soil is used mainly for grazing. It is too steep for cultivation. (Capability unit VIIe-2; North Exposure range site, 16 to 20 inches precipitation; windbreak group 7; not in a woodland group)

Mondovi Series

The Mondovi series consists of well-drained, nearly level soils of the bottom lands. These soils formed under grass in alluvium. Elevations range from 1,850 to 3,400 feet. The annual precipitation is 16 to 20 inches, and the mean annual temperature is about 49° F. The frost-free season is 125 to 135 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 28 inches thick. The underlying material is dark grayish-brown and grayish-brown silt loam to a depth of about 60 inches. The soil is slightly acid to neutral.

Soils of the Mondovi series are used mainly for wheat and barley.

Mondovi silt loam (Mo).-This soil is on bottom lands. Slopes are 0 to 3 percent.

Representative profile, 160 feet south and 1,320 feet west of the northeast corner of sec. 18, T. 12 N., R. 44 E.

Ap-0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, very fine and fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; slightly acid; gradual, wavy boundary.

A1-7 to 28 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, coarse, prismatic structure; slightly. hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores and common fine pores; black (10YR 2/1, moist) organic stains on ped surfaces and in old root channels; slightly acid; gradual, wavy boundary.

C1-28 to 47 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores and common fine pores; neutral; gradual, wavy boundary.

C2-47 to 60 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores and common fine pores; neutral.

In many places the C horizon contains alternate layers of black, very dark brown, very .dark grayish brown, and dark brown. In places the soil contains small amounts of gravel or cobblestones.

Permeability is moderate, and roots penetrate to a depth of more than 60 inches. The soil holds about 12 inches of water that plants can use. In most years the soil is slightly wet in spring and is somewhat susceptible to frost. Runoff is slow, and the hazard of water erosion is only slight. The hazard of wind erosion also is slight. Streambanks need protection from cutting in some places.

This soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IIc-2; windbreak group 4; not in a range site or woodland group)

Oliphant Series

The Oliphant series consists of well-drained soils of the uplands. These soils formed under bunchgrass in calcareous wind-laid silt. Bedrock is at a depth of 40 to more than 60 inches. Elevations range from 600 to 2,550 feet. Slopes are 0 to 55 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 150 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 16 inches thick. The subsoil is brown to pale-brown silt loam that is calcareous at a depth of about 26 inches. At a depth of 41 inches is white, slightly hard, calcareous very gravelly silt loam that extends to bedrock at a depth of about 53 inches. The soil is neutral in the surface layer, moderately alkaline in the subsoil, and strongly alkaline below.

Soils of the Oliphant series are used mainly for wheat, barley, hay, and pasture.

Oliphant-Spofford silt loams, 0 to 15 percent slopes (OsC).-This complex is on the basalt plateau. It is about 75 percent Oliphant silt loam and 25 percent Spofford silt loam. The Spofford soil occurs as small circular areas, 10 to 30 feet in diameter, that are intermingled with areas of the Oliphant soil.

Representative profile, 920 feet north and 680 feet west of the southeast corner of sec. 30, T. 13 N., R. 41 E.

Ap-0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly

sticky and slightly plastic; common roots; neutral; abrupt, wavy boundary.

A1-9 to 16 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many fine pores; mildly alkaline; clear, wavy boundary.

B21-16 to 26 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, coarse and medium, prismatic structure; hard, friable, sticky and plastic; common roots; common fine pores; moderately alkaline; clear, wavy boundary.

B22ca- 26 to 41 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak, medium, prismatic structure; slightly hard, friable, sticky and plastic; common roots; 10 to 15 basalt fragments per cubic foot, fragments are 1/4 to 3/4 inch in diameter; slight effervescence; strongly alkaline; clear, wavy boundary.

IICca-41 to 53 inches, white (10YR 8/2) very gravelly silt loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, friable, slightly sticky and nonplastic ; few roots; 60 to 80 percent is basalt fragments; strongly alkaline; violent effervescence; abrupt, wavy boundary.

IIIR-53 inches, basalt bedrock that contains lime in fractures.

The depth to bedrock ranges from 40 to more than 60 inches.

Permeability of the Oliphant soil is moderate, and rants penetrate to bedrock. The soil holds 7 to 12 inches of water that plants can use. Runoff is medium, and the hazard of erosion is moderate to severe.

This complex is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IVe-9; windbreak group 7; not in a range site or woodland group)

Oliphant silt loam, moderately shallow, 0 to 5 percent slopes (OnB).-This soil is on the basalt plateau. The areas range from 10 to 55 acres in size. In most places the slope is 2 to 5 percent.

Included with this soil in mapping were small areas where the slope is more than 5 percent, areas where bedrock is at a depth of less than 40 inches or more than 60 inches, and a few areas of Spofford silt loam, which occur as slickspots.

Runoff is slow, and the hazard of water erosion is slight.

This Oliphant soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IIe-1; windbreak group 2; not in a range site or woodland group)

Oliphant silt loam, moderately shallow, 5 to 25 percent slopes (OnD).-This soil is on uplands. The areas are 10 to 12 acres in size. In most places the slopes are between 6 and 20 percent.

Included with this soil in mapping were small areas where the slope is less than 5 percent or more than 25 percent and areas where bedrock is at a depth of less than 40 inches. Also included were a few areas of Spofford soil; in these areas the soil is alkali and occurs as slickspots.

Runoff is medium; most of it comes when snow melts rapidly in winter and early in spring and during rainstorms in spring and severe thunderstorms in summer. The hazard of water erosion is moderate, and the hazard of wind erosion is slight.

This Oliphant soil is used mainly for wheat, barley, alfalfa and grass. (Capability unit IIIe-1; windbreak group 2; not in a range site or woodland group)

Oliphant silt loam, moderately shallow, 25 to 40 percent slopes (OnE).-This soil is on side slopes descending from the basalt plateau. The surface layer is 9 to 14 inches thick. The areas range from 10 to 60 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent, areas where bedrock is at a depth of less than 40 inches or more than 60 inches, and a few small eroded areas where the calcareous subsoil is exposed.

Runoff is rapid, and the hazard of water erosion is severe.

This soil is used mainly for wheat, barley, alfalfa, and grass. More of the acreage is in alfalfa and grass than in wheat and barley. (Capability unit IVe-1; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Oliphant silt loam, 0 to 5 percent slopes (OlB).-This soil is on the basalt plateau. Bedrock is at a depth of more than 60 inches. The areas range from 10 to 200 acres in size. In most places the slope is 2 to 5 percent.

Included with this soil in mapping were small areas where the slope is more than 5 percent, areas where bedrock is at a depth of less than 60 inches, and a few areas of Spofford, silt loam, which occur as slickspots.

Runoff is slow, and the hazard of water erosion is slight. This soil holds 10 to 12 inches of water that plants can use.

This Oliphant soil is used mainly for wheat, barley, alfalfa, and brass. (Capability unit IIe-1; windbreak group 3 ; not in a range site or woodland group)

Oliphant silt loam, 5 to 25 percent slopes (OlD).This soil is on the basalt plateau. The depth to bedrock is more than 60 inches. The areas range from 10 to 100 acres in size.

Included with this soil in mapping were small areas where the slope is less than 5 percent or more than 25 percent, areas were bedrock is at a depth of less than 60 inches, and a few areas of Spofford silt loam, which occur as slickspots.

This soil holds 10 to 12 inches of water that plants can use.

This Oliphant soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IIIe-1; windbreak group 3; not in a range site or woodland group)

Oliphant silt loam, 25 to 40 percent slopes (OlE).This soil is on side slopes descending from the basalt plateau. The surface layer is 9 to 14 inches thick, and bedrock is at a depth of more than 60 inches. The areas range from 10 to 80 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent and areas where bedrock is at a depth of less than 60 inches. Also included were a few small eroded areas where the calcareous subsoil is exposed.

Runoff is rapid, and the hazard of water erosion is severe. This soil holds 10 to 12 inches of water that plants can use.

This soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IVe-1; Loamy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Oliphant silt loam, 40 to 55 percent slopes (OlF).This soil is on the sides of the basalt plateau. The surface

layer is 9 to 14 inches thick, and bedrock is at a depth of more than 60 inches. The areas range from 10 to 40 acres in size.

Included with this soil in mapping were small areas where the slope is less than 40 percent and areas where bedrock is at a depth of less than 60 inches.

Runoff is very rapid, and the hazard of water erosion is very severe. The soil holds 10 to 12 inches of water that plants can use.

This soil is used mainly for grazing. (Capability unit VIe-1; North Exposure range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Oliphant-Lance silt loams, 10 to 40 percent slopes, eroded (OpE2).-This complex consists of rolling to hilly soils on uplands. It is about 70 percent Oliphant silt loam and about 30 percent Lance silt loam, eroded. The Lance soil is in narrow strips along ridgetops, on small rounded knobs, and in convex areas of steep, south-facing slopes. It is scattered throughout the areas of Oliphant soil.

The Oliphant soil in this complex is more than 60 inches deep to bedrock. It holds 10 to 12 inches of water that plants can use.

Runoff is medium to rapid, and the erosion hazard is moderate to severe.

This complex is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IVe-1; windbreak group 7; not in a range site or woodland group)

Oliphant-Spofford silt loams,15 to 25 percent slopes OsD.-This complex is on side slopes of the basalt plateau. It is about 75 percent Oliphant silt loam and about 25 percent Spofford silt loam. The Spofford soil is scattered throughout areas of Oliphant silt loam. It occurs as small areas along the rim of shallow drainageways.

The Oliphant soil in this complex is more than 60 inches deep to bedrock. The soil holds 10 to 12 inches of water that plants can use.

Runoff is rapid, and hazard of erosion is severe.

This complex is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IVe-9; windbreak group 7; Loamy range site, 12 to 16 inches precipitation; not in a woodland group)

Onyx Series

The Onyx series consists of well-drained soils, nearly level along stream channels. These soils formed under bunchgrass in recent alluvium. Elevations range from 600 to 2,500 feet. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 155 days.

In a representative profile the surface layer is grayish-brown silt loam about 8 inches thick. The substratum is silt loam that extends to a depth of more than 60 inches. It is grayish brown in the upper part and brown in the lower part. The soil is neutral in the surface layer and mildly alkaline below.

Soils of the Onyx series are mainly used for wheat, barley, hay, and pasture.

Onyx silt loam (Ox).-This soil is along drainageways. Slopes range from 0 to 3 percent.

Representative profile, 720 feet west of the east quarter corner of see. 30, T. 12 N. R. 40 E.

Ap-0 to 8 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; neutral; abrupt, smooth boundary.

C1-8 to 33 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; many roots; many very fine and common fine pores; scattered basalt pebbles; mildly alkaline; gradual, wavy boundary.

C2-33 to 54 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; common roots; many very line and common fine pores; 1 percent basalt pebbles; mildly alkaline; clear, wavy boundary.

C3-54 to 70 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine and few fine pores; 5 percent basalt gravel; mildly alkaline; abrupt, wavy boundary.

IIC3-70 inches, waterworn basalt gravel.

The depth to waterworn basalt gravel is more than 40 inches. In some areas the soil contains thin lenses of very fine sandy loam, fine sandy loam, loamy fine sand, or very fine sand.

Included with this soil in mapping were small areas where the soil is calcareous and areas where the soil contains thin layers of volcanic ash.

Permeability is moderate, and roots penetrate to a depth of 60 inches or more. The soil holds 10 to 12 inches of water that plants can use. Runoff is slow. The hazards of water erosion and wind erosion are slight. Streambanks need protection from cutting.

This soil is used mainly for wheat, barley: alfalfa, and grass. It can be cultivated throughout a wide range of moisture content. (Capability unit IIc-1; windbreak group 3; not in a range site or woodland group)

Palouse Series

The Palouse series consists of well-drained soils of the uplands. These soils formed under grass and shrubs in wind-laid silt. Bedrock is at a depth of 40 to more than 60 inches. Elevations range from 3,000 to 4,500 feet. Slopes are 0 to 40 percent. The annual precipitation is 20 to 24 inches, and the mean annual temperature is about 47° F. The frost-free season is 125 to 135 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 15 inches thick. The subsoil is grayish-brown or pale-brown heavy silt loam that extends to a depth of 60 inches or more. The soil is neutral throughout.

Soils of the Palouse series are used mainly for wheat, barley, grass seed, hay, and pasture.

Palouse silt loam, 0 to 7 percent slopes (PaB).-This soil is on uplands. The areas range from 10 to 80 acres in size. In most places the slope is 3 to 7 percent.

Representative profile, 1,400 feet south and 2,330 feet east of the northwest corner of sec. 31, T. 10 N., R. 43 E.

Ap-0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; neutral; abrupt, smooth boundary.

A1-8 to 15 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; slightly hard, friable,

sticks and plastic; mans roots; many very fine pores; neutral; clear, wavy boundary.

B1-15 to 22 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; hard, friable, sticky and plastic; many roots; many very fine pores; few worm casts; neutral; clear, wavy boundary.

B21-22 to 34 inches, brown (10YR 5/3) heavy silt loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure; hard, friable, sticky and plastic; many roots; many very fine pores; very thin cutans that may be clay films in some pores; thin siliceous coatings on ped surfaces; numerous worm casts; neutral; gradual, wavy boundary.

B22-34 to 47 inches, pale-brown (10YR 6/3) heavy silt loam, brown (10YR 4/3) moist; moderate, medium, prismatic structure; hard, friable, sticky and plastic; common roots; many very fine pores; thin cutans that may be clay films in pores; thin siliceous coatings on ped surfaces; numerous worm casts; neutral; gradual, wavy boundary.

B23-47 to 60 inches, pale-brown (10YR 6/3) heavy silt loam, brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; common roots; many very fine pores and few medium pores; very thin cutans that may be clay films in pores; numerous worm casts; neutral.

The A horizon is as thin as 12 inches where slopes are short and convex and as thick as 18 inches where slopes are long and gentle. The combined thickness of the Ap, A1, and B1 horizons ranges from 20 to 30 inches.

Included with this soil in mapping were small areas where bedrock is at a depth of 40 to 60 inches. Also included were areas where the slope is 7 to 25 percent.

Permeability is moderate, and roots penetrate to a depth of 60 inches. The soil holds 11 to 13 inches of water that plants can use. Runoff is slow; most of it comes when snow melts early in spring. The hazards of water erosion and wind erosion are slight.

This soil is used mainly for wheat, barley, alfalfa, grass, and clover. (Capability unit IIe-2; windbreak group 5; not in a range site or woodland group)

Palouse silt loam, 7 to 25 percent slopes (PaD).-This soil is on uplands. It is similar to Palouse silt loam, 0 to 7 percent slopes, except for slope. The areas range from 10 to 50 acres in size.

Included with this soil in mapping were small areas where the slope is less than 7 percent or more than 25 percent. Also included were areas where bedrock is at a depth of less than 60 inches.

Runoff is medium, and the hazard of water erosion is moderate.

This soil is used mainly for wheat, barley, alfalfa, grass, and clover. (Capability unit IIIe-3; windbreak group 5; not in a range site or woodland group)

Palouse silt loam, moderately shallow, 0 to 7 percent slopes (PlB).-This soil is on basalt plateaus. It is similar to Palouse silt loam, 0 to 7 percent slopes, except that bedrock is at a depth of 40 to 60 inches. The areas range from 10 to 80 acres in size. In most places the slope is 3 to 7 percent.

Included with this soil in mapping were small areas where the slope is more than 7 percent and areas where bedrock is at a depth of less than 40 or more than 60 inches.

This soil is used mainly for wheat, barley, alfalfa, grass, and clover. It holds 8 to 12 inches of water that plants can use. (Capability unit IIe-2; windbreak group 4; not in a range site or woodland group)

Palouse silt loam, moderately shallow, 7 to 25 percent slopes (PlD).-This soil is on basalt plateaus. It is similar to Palouse silt loam, 0 to 7 percent slopes, except for slope and depth to bedrock. In this soil bedrock is at a depth of 40 to 60 inches. The areas range from 10 to 120 acres in size.

Included with this soil in mapping were small areas where the slope is less than 7 percent or more than 25 percent and areas where bedrock is at a depth of less than 40 inches or more than 60 inches.

Runoff is medium, and the hazard of water erosion is moderate.

This soil is used mainly for wheat, barley, alfalfa., grass, and clover. It holds 8 to 12 inches of water that plants can use. (Capability unit IIIe-3; windbreak group 4; not in a range site or woodland group)

Palouse silt loam, moderately shallow, 25 to 40 percent slopes (PlE).-This soil is on basalt plateaus. It is similar to Palouse silt loam, 0 to 7 percent slopes, except for slope, depth to bedrock, and thickness of the surface layer. In this soil bedrock is at a depth of 40 to 60 inches and the surface layer is 9 to 12 inches thick.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent and areas where bedrock is at a depth of less than 40 inches or more than 60 inches.

Runoff is rapid, and the hazard of water erosion is severe. Snowdrifts are common in winter.

This soil is used mainly for wheat, barley, alfalfa, grass, and clover. It holds 8 to 12 inches of water that plants can use. (Capability unit IVe-4; North Exposure range site, 20 to 24 inches precipitation; windbreak group 6; not in a woodland group)

Quincy Series

The Quincy series consists of excessively drained soils on sandy terraces along the Snake River. These soils formed under grass and shrubs in wind-blown sand. Elevations range from 600 to 800 feet. Slopes are 0 to 25 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is 50 ° F. In this survey area rainfall is slightly higher than is normal for the series. The frost-free season is 135 to 155 days.

In a representative profile the soil is grayish-brown, loamy fine sand to fine sand to a depth of 60 inches or more. It is mildly alkaline.

Soils of the Quincy series are used mainly for irrigated hay and pasture and for range.

Quincy loamy fine sand (Qu).-This soil is on low terraces along the Snake River. Slopes are 0 to 25 percent.

Representative profile, 2,200 feet west and 350 feet south of the northeast corner of sec. 23, T. 14 N., R. 42 E.

C1-0 to 28 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose, nonsticky and nonplastic; common roots; mildly alkaline; gradual, wavy boundary.

C2-28 to 60 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose, nonsticky and nonplastic ; few roots; mildly alkaline.

Included with this soil in mapping were areas of fine sand or fine sandy loam.

Permeability is rapid, and roots penetrate to a depth of more than 60 inches. The soil holds 3 to 5 inches of water that plants can use. Runoff is slow. The hazard of water erosion is only slight, but the hazard of wind erosion is severe.

This soil is too droughty to be used for dryland farming. It is suited to sprinkler irrigation. Alfalfa and grass are the main crops. Some areas are used for grazing. (Capability unit VIIe-1; Sandy range site, 12 to 16 inches precipitation; windbreak group 7; not in a woodland group)

Riverwash

Riverwash (Rw) consists of nearly level bars of coarse sand, gravel, and cobblestones along the Snake River and small streams. The areas are generally less than 3 feet above the normal level of the streams. Most of the areas are bare or nearly bare of vegetation.

Riverwash is subject to change in size and position, even when streamflow is normal. It is not suitable for cultivation or grazing. (Capability unit VIIIw-1; windbreak group 7; not in a range site or woodland group)

Rock Outcrop

Rock outcrop consists of areas of exposed basalt bedrock in the form of ledges, cliffs, and escarpments. In many places the escarpments interfere with the movement of livestock that are grazing adjoining areas of range.

This miscellaneous land type occurs in many small areas and is mapped only in complexes with soils of the Gwin, Flicker, and Lickskillet series.

Spofford Series

The Spofford series consists of well-drained soils of the uplands. These soils formed under bunchgrass in wind-laid silt. Elevations range from 800 to 3,000 feet. Slopes are 0 to 15 percent. The annual precipitation is 12 to 20 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 150 days.

In a representative profile the surface layer is grayish-brown silt loam and light brownish-gray loam about 4 inches thick. The subsoil is grayish-brown to yellowish-brown heavy silt loam about 23 inches thick. The substratum is pale-brown to light yellowish-brown, calcareous silt loam. The soil is moderately alkaline in the surface layer and strongly alkaline below.

Soils of the Spofford series are used mainly for wheat, barley, hay, and pasture. In this survey area they are mapped only in complexes with Asotin, Athena, and Oliphant soils.

Representative profile of Spofford silt loam in an area of Asotin-Spofford complex, 0 to 15 percent slopes, 800 feet south and 1,200 feet east of the center of sec. 24, T. 12 N., R. 42 E.

A1-0 to 3 3/4 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, thin and medium, platy structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine pores; mildly alkaline; abrupt, smooth boundary.

A2-3 3/4 to 4 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; many roots; mildly alkaline; abrupt, smooth boundary.

B21t-4 to 7 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; strong, medium, columnar structure; very hard, very firm, sticky and plastic; common roots; many very fine pores; clay films in pores; organic stains on ped surfaces; strongly alkaline; abrupt, wavy boundary.

B22t-7 to 15 inches, yellowish-brown (10YR 5/4) heavy silt loam, dark yellowish brown (10YR 3/4) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic-, common roots; many very fine pores; thin clay films in pores; strongly alkaline; clear, wavy boundary.

B23ca-15 to 27 inches, yellowish-brown (10YR 5/4) heavy silt loam, dark yellowish brown (10YR 3/4) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; free lime in pores and root channels; strong effervescence; strongly alkaline; abrupt, wavy boundary.

C1ca-27 to 44 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few roots.; many very fine pores; free lime throughout; violent effervescence; strongly alkaline; gradual, wavy boundary.

C2ca-44 to 60 inches, light yellowish-brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly' plastic; many very fine pores and few medium pores; free lime in some pores; violent effervescence; strongly alkaline.

Permeability is slow. The soils hold about 5 inches of water that plants can use. Runoff is medium, and the erosion hazard is moderate. In many places runoff from these soils causes serious rilling in areas of adjoining soils.

Tolo Series

The Tolo series consists of well-drained soils of mountainous uplands. These soils formed under mixed coniferous forest in volcanic ash and wind-laid silt. They are underlain by an older, buried soil. Elevations range from 3,250 to 4,500 feet. Slopes are 10 to 60 percent. The annual precipitation is 24 to 30 inches, and the mean annual temperature is about 45° F. The frost-free season is 100 to 120 days.

In a representative profile the uppermost 22 inches is yellowish-brown and light yellowish-brown silt loam that consists mostly of volcanic ash. The next layer is pale-brown silt loam about 12 inches thick. Below this is brown silty clay loam that extends to a depth of more than 60 inches. The soil is neutral.

Soils of the Tolo series are used mainly for woodland, recreation, wildlife habitat, and woodland grazing.

Tolo silt loam, 10 to 25 percent slopes (ToD).-This soil is on mountainous uplands. The areas are 15 to 30 acres in size.

Representative profile, 1,500 feet south and 650 feet east of the northeast corner of sec. 6, T. 9 N., R. 43 E.

01&02-2 inches to 0, needles, leaves, twigs, bark, moss, and wood fragments.

B21-0 to 14 inches, yellowish-brown (10YR 5/4) silt loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; soft, very friable, nonsticky and non-

plastic; mostly volcanic ash; many roots; few scattered pebbles of basalt; neutral; clear, wavy boundary.

B22-14 to 22 inches, light yellowish-brown (10YR 6/4) silt loam, dark brown (7.5YR 3/2) moist; weak, medium, subangular blocky structure; soft, very friable, nonsticky and nonplastic ; many roots; 1 percent is basalt gravel; neutral; gradual, wavy boundary.

IIA'21-22 to 27 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak, medium, subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many roots; many very fine pores; neutral; clear, wavy boundary.

IIA'22-27 to 34 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; many roots; many very fine pores; thin clay films on ped surfaces; 2 percent basalt gravel; neutral; clear, wavy boundary.

IIB'21t-34 to 47 inches, brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; strong, medium, prismatic structure breaking to strong, medium, subangular blocky; very hard, firm, very sticky and very plastic; common roots; common very fine pores thick clay films in pores and on ped surfaces ; 2 percent is basalt gravel; neutral; gradual, wavy boundary.

IIB'22t-27 to 61 inches, brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard, firm, very sticky and very plastic; common roots; common very fine pores; thin clay films in pores and on ped surfaces; 5 to 10 percent is basalt gravel; neutral; gradual, wavy boundary.

IIB'23-61 to 67 inches, broken basalt; material from IIB'22t horizon in fractures.

IIIR-67 inches, basalt bedrock.

Included with this soil in mapping were small areas where the slope is less than 10 percent or more than 25 percent and areas where basalt bedrock is at a depth of less than 60 inches.

Permeability is moderately slow, and roots penetrate to a depth of more than 60 inches. The soil holds 8 to 11 inches of water that plants can use. Runoff is medium; most of it comes from melting snow in spring and during rainstorms late in spring and in fall. The hazard of water erosion is moderate.

This soil is used mainly for woodland, recreation, and wildlife habitat. (Capability unit VIe-3; woodland group 30; not in a range site or windbreak group)

Tolo silt loam, 25 to 40 percent slopes (ToE).-This soil is on north- or east-facing side slopes descending from the basalt plateau. It is similar to Tolo silt loam, 10 to 25 percent slopes, except for slope. The areas range from 30 to 200 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent and areas where basalt bedrock is at a depth of less than 60 inches.

Runoff is rapid, and the hazard of water erosion is severe.

This soil is used mainly for woodland, recreation, and wildlife habitat. (Capability unit VIe-3 ; woodland group 2r; not in a range site or windbreak group)

Tolo silt loam, 40 to 60 percent slopes (ToF).-This soil is on north- or east-facing side slopes descending from the basalt plateau. It is similar to Tolo silt loam, 10 to 25 percent slopes, except for slope. The areas range from 25 to 200 acres in size.

Included with this soil in mapping were small areas where the slope is less than 40 percent and areas where basalt bedrock is at a depth of less than 60 inches.

Runoff is very rapid, and the hazard of water erosion is very severe.

This soil is used for woodland, recreation, and wildlife habitat. (Capability unit VIe-3; woodland group 2r; not in a range site or windbreak group)

Waha Series

The Waha series consists of well-drained soils of the uplands. These soils formed under grass and small shrubs in a mixture of wind-laid silt and material weathered from basalt. Elevations range from 3,000 to 4,500 feet. Slopes are 0 to 40 percent. The annual precipitation is 20 to 24 inches, and the mean annual temperature is about 4l° F. The frost-free season is 115 to 135 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 13 inches thick. The subsoil is brown, hard light silty clay loam; it overlies basalt bedrock at a depth of 35 inches. The soil is slightly acid in the surface layer and neutral in the subsoil.

Soils on the Waha series are used mainly for wheat, barley, grass seed, hay, and pasture.

Waha silt loam, 0 to 15 percent slopes (WaC).-This soil is on the basalt plateau. In most places the slope is between 3 and 10 percent.

Representative profile, 1,040 feet south and 20 feet east of the northwest corner of sec. 31, T. 10 N., R. 43 E.

Ap-0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, very fine and fine, granular structure; slightly hard, friable, sticky and plastic; many roots; about 1 percent basalt fragments; slightly acid; abrupt, wavy boundary.

A1-7 to 13 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) moist; moderate, medium and coarse, granular structure; hard, firm, sticky and plastic; many roots; 1 percent basalt fragments; organic stains on ped surfaces; slightly acid; clear, wavy boundary.

B21t-13 to 22 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 3/3) moist; weak, medium. prismatic structure breaking to moderate medium, subangular blocky; hard, firm, sticky and plastic; many roots; 1 percent basalt fragments; many very fine and medium pores; thin clay films on some ped surfaces and in some pores; few manganese shot; krotovinas, 2 inches long, of material from the A horizon; slightly acid; gradual, wavy boundary.

B22t-22 to 30 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 3/3) moist; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard, firm, sticky and plastic; common roots; 4 percent basalt fragments; few medium pores and many very fine pores; thin clay films on ped surfaces and in pores; Pew manganese shot; neutral; abrupt, wavy boundary.

IIB3t-30 to 35 inches, brown (10YR 5/3) very cobbly silty clay loam, dark brown (10YR 3/3) moist; massive; hard, firm, sticky and plastic; few roots; 60 to 80 percent basalt fragments; neutral; clear, wavy boundary.

IIR-35 inches, basalt bedrock.

The depth to bedrock ranges from 24 to 40 inches.

Included with this soil in mapping were small areas where the slope is more than 15 percent, areas where bed-

rock is at a depth of less than 24 inches or more than 40 inches, and areas where the surface layer is gravelly.

Permeability is moderately slow, and roots penetrate to bedrock. The soil holds 5 to 7 inches of water that plants can use. Runoff is slow to medium; most of it comes when snow melts rapidly in winter and early in spring and during rainstorms in spring. The hazard of water erosion is moderate, and the hazard of wind erosion is slight.

This soil is used mainly for wheat, barley, alfalfa, grass, and clover. (Capability unit IIIe-5; windbreak group 4; not in a range site or woodland group)

Waha silt loam, 15 to 25 percent slopes (WaD).-This soil is along drainageways and on the sides of the basalt plateau. It is similar to Waha silt loam, 0 to 15 percent slopes, except for slope. The areas range from 4 to 30 acres in size.

Included with this soil in mapping were small areas where the slope is less than 15 percent or more than 25 percent, areas where bedrock is at a depth of less than 24 inches or more than 40 inches, and areas where the surface layer is gravelly.

Runoff is medium to rapid, and the hazard of water erosion is moderate to severe.

This soil is used mainly for wheat, barley, alfalfa, grass and clover. (Capability unit IVe-7; windbreak group 4; not in a range site or woodland group)

Waha silt loam, 25 to 40 percent slopes (WaE).-This soil is on the sides of the basalt plateau. It is similar to Waha silt loam, 0 to 15 percent slopes, except for slope.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent, areas where bedrock is at a depth of less than 24 inches or more than 40 inches, and areas where the soil is stony.

Runoff is rapid, and the hazard of water erosion is severe.

This soil is used mainly for grazing. (Capability unit VIe-2; Loamy range site, 16 to 24 inches precipitation; windbreak group 7; not in a woodland group)

Walla Walla Series

The Walla Walla series consists of well-drained soils of the uplands. These soils formed under grass in wind-laid silt. Elevations range from 800 to 2,550 feet. Slopes are 0 to 50 percent. The annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50° F. The frost-free season is 135 to 150 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 14 inches thick. The subsoil is brown silt loam that reaches to a depth of 40 inches. This is underlain by a substratum of pale-brown silt loam that reaches to a depth of more than 60 inches. The soil is neutral in the surface layer and mildly to moderately alkaline below.

Soils of the Walla Walla series are used mainly for wheat, barley, alfalfa, and grass.

Walla Walla silt loam, 7 to 25 percent slopes (WwD).-This soil is on uplands. The areas range from 10 to 150 acres in size.

Representative profile, 400 feet north and 300 feet east of the southwest corner of sec. 21, T. 12 N., R. 40 E.

Ap-0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; neutral; clear, wavy boundary.

A1-8 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; mildly alkaline; gradual, wavy boundary.

B2-14 to 40 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, medium, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many roots to a depth of 26 inches and common roots to a depth of 40 inches; common very fine pores; mildly alkaline; gradual, wavy boundary.

C1-40 to 54 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 6/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; common very fine pores; mildly alkaline; clear, wavy boundary.

C2-54 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots, few very fine pores; moderately alkaline.

Included with this soil in mapping were small areas where the slope is less than 7 percent or more than 25 percent, areas where basalt bedrock is at a depth of less than 60 inches, and areas where the soil is calcareous at a depth of more than 50 inches. Also included were a, few areas of Spofford silt loam; in these areas the soil is alkali and occurs as slickspots.

Permeability is moderate, and roots penetrate to a depth of more than 60 inches. The soil holds 11 to 13 inches of water that plants can use. Runoff is medium; most of it comes when snow melts rabidly in winter and early in spring or during rainstorms in spring and severe thunderstorms in summer. The hazard of water erosion is moderate, and the hazard of wind erosion is slight.

This Walla Walla soil is used mainly for wheat, barley, alfalfa, and grass. It can be cultivated throughout a wide range of moisture content. (Capability unit IIIe-1; windbreak group 3; not in a range site or woodland group)

Walla Walla silt loam, 0 to 7 percent slopes (WwB).-This soil is on uplands. It is similar to Walla Walla silt loam, 7 to 25 percent slopes, except for slope. The areas range from 10 to 100 acres in size.

Included with this soil in mapping were areas where the slope is more than 7 percent.

Runoff is slow. The hazards of water erosion and wind erosion are slight.

This soil is used for wheat, barley, alfalfa, and grass. (Capability unit IIe-1; windbreak group 3 ; not in a range site or woodland group)

Walla Walla silt loam, 25 to 40 percent slopes (WwE).-This soil is on uplands. It is similar to Walla Walla silt loam, 7 to 25 percent slopes, except for slope and the thickness of the surface layer. In this soil the surface layer is 9 to 14 inches thick. The areas range from 10 to 50 acres in size.

Included with this soil in mapping were small areas where the slope is less than 25 percent or more than 40 percent.

Runoff is rapid, and the hazard of water erosion is severe.

This soil is used mainly for wheat, barley, alfalfa, and grass. (Capability unit IVe-1; Loamy range site, 12 to

16 inches precipitation; windbreak group 7; not in a woodland group)

Walla Walla silt loam, 40 to 55 percent slopes (WwF).- This soil is on uplands. It is similar to Walla Walla silt loam, 7 to 25 percent slopes, except for slope. The areas range from 10 to 300 acres in size.

Included with this soil in mapping were areas where the slope is less than 40 percent.

Runoff is very rapid, and the hazard of water erosion is very severe.

This soil is used mainly for grazing. (Capability unit VIe-1; North Exposure range site, 12 to 16 inches precipitation; windbreak group; not in a woodland group)

Use and Management of the Soils

This section contains information about the use and management of the soils of the Garfield County Area for crops, range, woodland, windbreaks, wildlife, and engineering. It explains the system of capability classification used by, the Soil Conservation Service and gives estimated yields of the principal crops.

This section also groups the soils according to their suitability for range and for woodland and windbreaks, and it discusses the use of the soils for wildlife habitat. It contains two tables that give information about the soils significant in engineering.

General Principles of Soil Management

In the Garfield County Area there are wide variations in topography, precipitation, vegetation, and kinds of soil. These differences lead to a diversity of problems or limitations in land use and management.

Most of the cropland is on soils where the slope is 5 to 40 percent. When the ground is frozen, rainfall or melting snow often cause excessive runoff and severe erosion. The control of water erosion is a major concern of management..

Only a. small dart of the annual precipitation comes during the growing season. Water conservation is necessary, especially in the drier parts of the survey area, to hold enough water in the soil available to plants through the dry season.

In this area good soil management calls for rotation of crops; maintenance of organic-matter content; minimum, but timely, tillage; proper choice and application of fertilizer; control of weeds; and control of erosion. Grain and grasses respond to nitrogen. Legumes generally respond to sulfur, boron, and phosphorus. Grain and domestic grasses, especially if grown 2 years or more in succession, respond to sulfur.

Range and woodland should be managed to encourage growth of native plants. Good forest management is necessary to maintain the timber supply and the efficiency of the watersheds.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive land-forming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering

In the capability system,, the kinds of soils are grouped at three levels; the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows

Class I soils have few limitations that restrict their use. (None in this survey area.)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit use largely to pasture, range, woodland, or wildlife. (None in this survey area.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; .they are designated by adding a small letter, *e, w, s;* or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In Class I there are no subclasses because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w, s,* and *c*, be-

cause the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-2 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in the Garfield County Area. are described, and suggestions for the use and management of the soils are given. The names of the soil series represented are mentioned in the description of each capability unit, but the listing of the series name does not necessarily indicate that all the soils of a series are in the same unit. The capability unit of any given soil can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT IIe-1

This unit consists of well-drained soils of the Chard, Oliphant, and Walla Walla series. These soils are more than 40 inches deep to bedrock. Slopes range from 0 to 7 percent, but in most places the slope is 3 to 7 percent. The annual precipitation ranges from 12 to 16 inches. The frost-free season is 135 to 155 days.

Permeability is moderate, and the soils hold 5 to more than 12 inches of water that plants can use. Surface runoff is slow. The hazards of water erosion and wind erosion are slight.

All the crops that are suited to the climate and that need good drainage grow well on these soils. Wheat, barley, alfalfa, and grass are the principal crops. They are commonly grown in rotations that consist of grain-fallow or a combination of alfalfa and grass followed by grain and fallow. Small areas of the Chard soil along the Snake River are irrigated.

These soils can be farmed in a wheat-fallow rotation without excessive erosion if waterways are shaped and seeded to grass, if stubble-mulch tillage is used. and crop residue is mixed into the tillage layer, if tillage is across the slope, and if fall grain is seeded early enough to provide winter cover. If no winter cover crop is grown and no stubble is left standing, the surface should be kept rough and cloddy through the winter. Diversions or stripcropping are needed to control erosion where the slopes are longer than about 700 feet or where the soils lack a cover of grasses or legumes. If steeper soils are upslope from the soils of this unit, diversions are needed in places to intercept runoff.

Growing grass and legumes in the rotation helps to control erosion and to maintain or improve tilth. Chiseling to a depth of more than 10 inches may be needed every second crop to break tillage pans.

CAPABILITY UNIT IIe-2

This unit consists of well-drained soils of the Athena and Palouse series. These soils are more than 40 inches deep to bedrock. Slopes range from 0 to 7 percent. The annual precipitation ranges from 16 to 24 inches. The frost-free season is 125 to 145 days.

Permeability is moderate, and the soils hold 8 to more than 12 inches of water that plants can use. Surface runoff is slow. The hazards of water erosion and wind erosion are slight.

The soils of this unit can be cultivated year after year. All the crops that are suited to the climate and that need good drainage grow well. Wheat, barley, alfalfa, and grass are the principal crops. They are commonly grown in rotations that consist of grain-fallow or a combination of alfalfa and grass followed by grain and fallow.

These soils can be farmed in a wheat-fallow rotation without excessive erosion if waterways are shaded, packed, and seeded to grass, if all crop residue is mixed into the tillage layer, if tillage is across the slope, and if fall grain is seeded early enough to provide winter cover. If no winter cover crop is grown and no stubble is left standing, the surface should be kept rough and cloddy through the winter. Diversions or stripcropping are needed to control erosion where the slopes are longer than about 500 feet or where the soils lack a cover of grasses or legumes. If steeper soils are upslope from the soils of this unit, diversions are needed in places to intercept runoff.

Growing grass and legumes in the rotation helps to control erosion and to maintain or improve tilth. Chiseling to a depth of more than 10 inches may be needed every second crop to break tillage pans.

CAPABILITY UNIT IIc-1

This unit consists of well-drained soils of the Hermiston and Onyx series. These soils are along streams and are occasionally flooded for short periods of time. They are more than 60 inches deep to bedrock. Slopes range from 0 to 3 hallow, 25 to 40 percent slopes (PlE).-This soil is on basalt plateaus. It is similar to Palouse silt

Permeability is moderate, and the soils hold 10 to more than 12 inches of water that plants can use. Surface runoff is slow. The hazards of water erosion and wind erosion are slight.

All the crops that are suited to the climate and that need good drainage grow well. Wheat, barley, alfalfa, and grass are the principal crops. They are commonly grown in rotations that consist of grain-fallow or a combination of alfalfa and grass followed by grain and fallow. Annual crops are grown in years when precipitation is above normal. Small areas are irrigated.

These soils can be farmed in a wheat-fallow rotation without excessive erosion if all crop residue is mixed into the tillage layer, if tillage is across the slope, and if fall grain is seeded early enough to provide winter cover. If no winter cover crop is grown and no stubble is left standing, the surface should be kept rough and cloddy through the winter. If steeper soils are upslope from the soils of this unit, diversions are needed in places to intercept runoff. Waterways, shaped and seeded to grass, carry runoff safely across these soils.

Growing grass and legumes in the rotation helps to control erosion and to maintain or improve tilth. Chisel-

ing to a depth of more than 10 inches will break up tillage pans. Streambank protection is needed in some places to control erosion.

CAPABILITY UNIT IIc-2

This unit consists of Mondovi silt loam, a well-drained soil that is more than 60 inches deep to bedrock. Slopes range from 0 to 5 percent, but in most places the slope is 0 to 3 percent. The annual precipitation ranges from 16 to 20 inches. The frost-free season is 125 to 135 days.

Permeability is moderate, and the soil holds more than 12 inches of water that plants can use. Surface runoff is slow. The hazards of wind erosion and water erosion are slight.

This soil can be cultivated year after year. All the crops that are suited to the climate and that need good drainage grow well on this soil. Wheat, barley, alfalfa, and grass are the principal crops.

This soil can be farmed without excessive erosion if all crop residue is mixed into the tillage layer, if tillage is across the slope, and if fall grain is seeded early enough to provide winter cover. If no winter cover crop is grown and no stubble is left standing, the surface should be kept rough and cloddy through the winter. If steeper soils are upslope from this soil, diversions are needed in places to intercept runoff. Waterways, shaped and seeded to grass, carry runoff safely across this soil.

Growing grass and legumes in the rotation helps to control erosion and to maintain or improve tilth. Chiseling to a depth of more than 10 inches will break up tillage pans. Channel improvement is needed along some streams to protect the soil from streambank cutting. Usually, this soil is slightly wet in spring and is somewhat susceptible to frost.

CAPABILITY UNIT IIIe-1

This unit consists of well-drained soils of the Chard, Oliphant, and Walla Walla series. These soils are more than 40 inches deep to bedrock. Slopes range from 5 to 25 percent. The annual precipitation ranges from 12 to 16 inches. The frost-free season is 135 to 155 days.

Permeability is moderate to moderately rapid, and the soils hold 5 to more than 12 inches of water that plants can use. Normally, surface runoff is medium and the hazard of water erosion is moderate. If the ground is frozen, however, runoff is rapid and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

All the crops that are suited to the climate and that need good drainage grow well on these soils. Wheat, barley, alfalfa, and grass are the principal crops. They are commonly grown in rotations that consist of grain-fallow, alfalfa-grain-fallow, grass-grain-fallow, or a combination of alfalfa and grass followed by grain and fallow.

These soils can be farmed in a wheat-fallow rotation without excessive erosion if waterways are shaped and seeded to grass, if stubble-mulch tillage is used, if all tillage is on the contour, and if fall grain is seeded early enough to provide winter cover. Diversions or stripcropping are needed to control erosion where the slopes are longer than about 350 feet or where the soils lack a cover of grasses or legumes. If steeper soils are upslope from the soils of this unit, diversions are needed in places to intercept runoff. Chiseling to a depth of more than 10 inches may be needed every second or third crop to break tillage pans. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring.

Growing grass or legumes in the rotation helps to control erosion and to maintain or improve tilth. When plowing out a crop of grass or legumes, the plow furrow should be turned uphill.

CAPABILITY UNIT IIIe-2

This unit consists of well-drained soils of the Anders and Asotin series. These soils are 20 to 40 inches deep to basalt bedrock. Slopes range. from 0 to 7 percent. The annual precipitation ranges from 12 to 16 inches. The frost-free season is 135 to 150 days.

Permeability is moderate, and the soils hold 4 to 8 inches of water that plants can use. Normally, surface runoff is slow and the hazard of water erosion is slight. If the ground is frozen, however, runoff is rapid and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, grass, and legumes are. the principal crops. These crops are commonly grown in rotations that consist of grain-fallow, grass-grain-fallow, or a combination of alfalfa and grass followed by grain and fallow.

These soils can be farmed in a wheat-fallow rotation without excess erosion if waterways are shaped, packed, and seeded to grass, if stubble-mulch tillage is used, if all tillage is on the contour, and if fall grain is seeded early enough to provide winter cover. Diversions or stripcropping is needed to control erosion where the slopes are more than about 350 feet or where the soils lack a cover of grasses or legumes. Runoff from soils upslope must be intercepted and disposed of safely because the soils in this unit are moderately shallow. Chiseling to a depth of more than 10 inches may be needed every-second year to break tillage pans. Chiseling also allows deeper penetration of moisture in winter and slows runoff in spring.

Growing grass or legumes in the rotation helps to control erosion and to maintain or improve tilth. When plowing out a crop of grass or legumes, the plow furrow should be turned uphill.

CAPABILITY UNIT IIIe-3

This unit consists of well-drained soils of the Athena and Palouse series. These soils are more than 40 inches deep to bedrock. Slopes range from 7 to 25 percent. The annual precipitation ranges from 16 to 24 inches. The frost-free season is 125 to 145 days.

Permeability is moderate, and the soils hold 8 to more than 12 inches of water that plants can use. Normally, surface runoff is medium and the hazard of water erosion is moderate. If the ground is frozen, however, runoff is rapid and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

These soils can be cultivated year after year. All the crops suited to the climate and that need good drainage grow well. Wheat, barley, alfalfa, and grass are the principal crops. They are commonly grown in rotations that consist of grain-fallow, grass-grain-fallow, or a combination of alfalfa and grass followed by grain and fallow.

These soils can be farmed in a wheat-fallow rotation without excessive erosion if waterways are shaped, packed, and seeded to grass, if all crop residue is mixed into the tillage layer, if all tillage is on the contour, and

if fall grain is seeded early enough to provide winter cover. Diversions or stripcropping is needed to control erosion where slopes are longer than about 250 feet or where the soils lack a cover of grasses or legumes. If steeper soils are upslope from the soils of this capability unit, diversions are needed in places to intercept runoff. Chiseling to a depth of more than 10 inches may be needed every second crop to break tillage pans. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring.

Growing grass or legumes in the rotation helps to control erosion and to maintain or improve tilth. When plowing out a crop of grass or legumes, the plow furrow should be turned uphill.

CAPABILITY UNIT IIIe-4

This unit consists of Asotin silt loam, high rainfall, 0 to 15 percent slopes, a well-drained soil that is 20 to 40 inches deep to basalt bedrock. The annual precipitation ranges from 16 to 20 inches. The frost-free season is 135 to 145 days.

Permeability is moderate, and the soil holds 5 to 8 inches of water that plants can use. Normally, surface runoff is slow to medium and the hazard of water erosion is slight to moderate. If the ground is frozen, however, runoff is rapid and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, grass, and legumes are the principal crops. These crops are commonly grown in rotations that consist of grain-fallow, grass-grain-fallow, or a combination of alfalfa and grass followed by grain and fallow.

This soil can be farmed in a wheat-fallow rotation without excessive erosion if waterways are shaped, packed, and seeded to grass, if all crop residue is mixed into the tillage layer, if all tillage is on the contour, and if fall grain is seeded early enough to provide winter cover. Diversions or stripcropping is needed to control erosion where slopes are longer than about 250 feet or where the soils lack a cover of grasses or legumes. Runoff from soils upslope must be intercepted and disposed of safely because the soil in this unit is moderately shallow. Chiseling to a depth of more than 10 inches may be needed every second year to break tillage pans. Chiseling also allows deeper penetration of moisture in winter and slow runoff in spring.

Growing grass or legumes in the rotation helps to control erosion and to maintain or improve tilth. When plowing out a crop of grass or legumes, the plow furrow should be turned uphill.

CAPABILITY UNIT IIIe-5

This unit consists of Waha silt loam, 0 to 15 percent slopes, a. well-drained soil that is 24 to 40 inches deep to basalt bedrock. The annual precipitation ranges from 20 to 24 inches. The frost-free season is 115 to 135 days.

Permeability is moderately slow, and the soil holds 5 to 7 inches of water that plants can use. Normally, surface runoff is slow to medium and the hazard of water erosion is moderate. If the ground is frozen, however, runoff is rapid and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, grass, and legumes are the principal crops. These crops are commonly grown in rotations that consist of grain-fallow, grass-grain-fallow, or a combination of alfalfa and grass followed by grain and fallow.

This soil cannot be safely farmed in a grain-fallow rotation. Because the soil is moderately shallow, it can be cropped annually since fallowing does not store enough moisture to be worthwhile. The soil should have a cover of vegetation during periods when runoff can cause severe water erosion. Erosion can be controlled if a winter cover crop is grown or stubble is left standing through the winter, if tillage is on the contour or across the slope, if all crop residue is returned, if fall grain is seeded early enough to provide soil cover, and if waterways are shaped, packed, and seeded to grass. Diversions or stripcropping is needed to control erosion where the slopes are longer than about 250 feet or where the soil lacks a cover of grasses or legumes. Runoff from soils upslope must be intercepted and disposed of safely because the soil in this unit is moderately shallow; diversions are needed in places. Chiseling to a depth of more than 10 inches may be needed every second or third crop to break tillage pans. Chiseling also allows deeper penetration of moisture in winter and slows runoff in spring.

CAPABILITY UNIT IIIe-6

This unit consists of Larkin silt loam, 0 to 15 percent slopes, a well-drained soil that is more than 40 inches deep to bedrock. The annual precipitation ranges from 22 to 30 inches. The frost-free season is 100 to 120 days.

Permeability is moderately slow, and the soil holds 8 to 11 inches of water that plants can use. Normally, surface runoff is slow to medium and the hazard of water erosion is slight to moderate. If the ground is frozen, however, runoff is rapid and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Most of the acreage is used for woodland. Wheat, barley, grass, and legumes are the principal crops in areas that are farmed.

If this soil is cultivated, a vegetative cover should be maintained year around. Grasses and legumes should be used in rotation with grain. Erosion can be controlled if a. winter cover crop is grown or stubble is left standing through the winter, if tillage is on the contour or across the slope, if all crop residue is returned, if fall grain is seeded early enough to provide soil cover, and if waterways are shaped and seeded to grass. Diversions or stripcropping is needed to control erosion where the slopes are longer than about 200 feet or where the soil lacks a cover of grasses or legumes. If steeper soils are upslope, diversions are needed in places to intercept runoff. Chiseling to a depth of more than 10 inches may be needed every second or third crop to break tillage pans. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring.

CAPABILITY UNIT IVe-1

This unit consists of well-drained soils of the Chard, Lance, Oliphant, and Walla Walla series. These soils are more than 40 inches deep to bedrock. Slopes range from 25 to 40 percent. The annual precipitation ranges from 12 to 20 inches. The frost-free season is 135 to 155 days.

Permeability is moderate, and the soils hold 8 to 12 inches of water that plants can use. Normally, surface runoff is rapid and the hazard of water erosion is severe.

If the ground is frozen, however, runoff is very rapid and water erosion is very severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, alfalfa, and grass are the principal crops. They are commonly grown in rotations that consist of grain-fallow or a combination of alfalfa and grass followed by fallow.

The soils of this unit cannot be safely farmed in a grain-fallow rotation. They should have a cover of grass or a combination of grass and legumes about half the time. An example of a suitable rotation is 3 to 5 years of grass or grass and alfalfa and 3 to 5 years of grain followed by fallow. The length of time that grass is grown should be extended to about three-fourths of the rotation period for soils of the Oliphant-Lance complex because these soils are eroded and need additional protection against erosion.

Fall grain should be seeded early enough to insure adequate soil cover during periods when runoff is very rapid. Stubble should be left standing through the winter, and all crop residue should be returned to the soils. The number of tillage operations should be as few as possible and only enough to control weeds. Tillage operations should be across the slope, at or near the contour. Stripcropping is needed to control erosion where the slopes are longer than 200 feet. If the watershed area is sufficiently extensive, diversions may be needed to intercept runoff before it reaches these soils.

Although erosion cannot be controlled in a grain-fallow rotation, it can be greatly reduced by following the practices given and by stripcropping with alternate strips of grain and fallow no wider than 100 feet. Chemical control of weeds reduces the need for tillage during fallow periods.

Drifting snow can be expected on the soils of this unit. The snow smothers fall-seeded grain, permits weeds to invade, and causes excessive rilling or deep slippage of the soil during spring snowmelt. The damage caused by snow can be limited by leaving stubble on hilltops and on the upper parts of adjacent south- and west-facing slopes, by planting windbreaks to intercept the snow before it reaches these soils, and by chiseling the higher lying soils so that the soils upslope can absorb more of the moisture during snowmelt.

CAPABILITY UNIT IVe-2

This unit consists of Chard very fine sandy loam, 7 to 25 percent slopes, eroded, a well-drained soil that is more than 60 inches deep to bedrock. Slopes range from 7 to 25 percent. The annual precipitation ranges from 12 to 16 inches: The frost-free season is 135 to 155 days.

Permeability is moderately rapid, and the soil holds about 6 to 8 inches of water that plants can use. Surface runoff is slow to medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

Wheat, barley, and grass are the principal crops. They are commonly grown in a rotation that consists of legumes-grain-fallow, grass-grain-fallow, or a combination of grass and legumes followed by grain and fallow.

The soil in this unit cannot be safely farmed in a grain-fallow rotation. It should have a cover of grass or grass and legumes at least 60 percent of the time. Erosion can be controlled if a suitable rotation is followed, if a winter cover crop is grown or stubble is left standing through the winter, if tillage is on the contour or across the slope, if all crop residue is returned, if fall grain is seeded early enough to provide winter cover, and if waterways are shaped, packed, and seeded to grass. If steeper soils are upslope from this soil, diversions are needed in places to intercept runoff. Stripcropping, using alternate strips no wider than 165 feet, helps to control wind erosion.

CAPABILITY UNIT IVe-3

This unit consists of Asotin silt loam, 7 to 25 percent slopes, a well-drained soil that is 23 to 38 inches deep to bedrock. Slopes range from 7 to 25 percent. The annual precipitation ranges from 12 to 16 inches. The frost-free season is 135 to 155 days.

Permeability is moderate, and the soil holds 4 to 7 inches of water that plants can use. Normally, surface runoff is medium to moderately rapid and the hazard of water erosion is moderate. If the ground is frozen, however, runoff is rapid and water erosion is very severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, grass, and legumes are the principal crops. They are commonly grown in rotations that consist of grain-fallow, grass-grain-fallow, alfalfa-grain-fallow, or a combination of alfalfa and grass followed by grain and fallow.

The soil in this unit cannot be safely farmed in a grain-fallow rotation. It should have a. cover of grass or grass and legumes about half the time. An example of a suitable rotation is 3 to 5 years of grass or legumes, or a combination of grass and legumes, followed by 3 to 5 years of grain-fallow. In this rotation erosion can be controlled if a winter cover crop is grown or stubble is left standing through the winter, if tillage is on the contour or across the slope, if all crop residue is returned, if fall grain is seeded early enough to provide winter cover, and if waterways are shaped and seeded to grass. Diversions or stripcropping are needed to control erosion where the slopes are longer than 200 feet or where the soil lacks a cover of grass or legumes. Runoff from soils upslope must be intercepted and disposed of safely because the soil in this unit is moderately shallow.

Although erosion cannot be controlled in a grain-fallow rotation, it can be greatly reduced by following the practices given and by stripcropping with alternate strips of grain and fallow no wider than 150 feet. Chemical control of weeds reduces the need for tillage during fallow periods. Chiseling to a depth of more than 10 inches may be needed every second crop to break tillage pans. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring. '

CAPABILITY UNIT IVe-1

This unit consists of well-drained soils of the Athena, Lance, and Palouse series. These soils are more than 40 inches deep to bedrock. Slopes range from 25 to 40 percent. The annual precipitation ranges from 16 to 24 inches. The frost-free season is 125 to 145 days.

Permeability is moderate, and the soils hold 8 to 12 inches of water that plants can use. Surface runoff is rapid, and the hazard of water erosion is severe. Also, there is a strong tendency for tillage operations to move soil material downhill. The hazard of wind erosion is slight.

Wheat, barley, alfalfa, and grass are the principal crops. They are commonly grown in rotations that consist of grain-fallow or a combination of alfalfa and grass followed by grain and fallow.

The soils of this capability unit cannot be safely farmed in a grain-fallow rotation. They should have a cover of grass or grass and legumes about half the time. An example of a suitable rotation is 3 to 5 years of grass or legumes, or a combination of grass and legumes, followed by 3 to 5 years of grain-fallow. The length of time that grass is grown should be extended to about three-fourths of the rotation period for soils of the Athena-Lance complex because these soils are eroded and need additional protection against erosion.

Fall grain should be seeded early enough to insure adequate soil cover during periods when runoff is rapid. Stubble should be left standing through the winter, and all crop residue should be returned. Waterways should be shaped, packed, and seeded to grass. Tillage and seeding should be across the slope, at or near the contour. Stripcropping is needed to control erosion, diversions are needed in places to intercept runoff before it reaches the soils of this unit.

Although erosion cannot be controlled in a grain-fallow rotation, it can be greatly reduced by following the practices given and by stripcropping with alternate strips of gram and fallow no wider than 100 feet. Chemical control of weeds reduces the need for tillage during fallow periods.

Drifting snow is common on these soils. The snow smothers fall-seeded grain, permits weeds to invade, and causes excessive rilling or deep slippage of the soil during spring snowmelt. The damage caused by snow can be limited by leaving stubble on hilltops and on the upper parts of adjacent south- and west-facing slopes, by planting windbreaks to intercept the snow before it reaches these soils, and by chiseling the higher lying soils so that the soils upslope can absorb more of the moisture during snowmelt.

CAPABILITY UNIT IVe-5

The unit consists of well-drained soils of the Athena and Spofford series. These soils are in complexes that consist of about 75 percent Athena soils and about 25 percent Spofford soils. The Spofford soils occur as roughly circular slickspots that range from 10 to 30 feet in diameter. All the soils of this unit are more than 40 inches deep to bedrock, Slopes range from 0 to 25 percent. The annual precipitation ranges from 16 to 20 inches. The frost-free season is 135 to 145 days.

Permeability is moderate to slow, and the soils hold 3 to more than 10 inches of water that plants can use. Normally, surface runoff is medium on the Athena soils and rapid on the Spofford soils and the hazard of water erosion is moderate to severe. If the ground is frozen, however, runoff is rapid on the Athena soils and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, grass, and legumes are the principal crops. They are commonly grown in rotations that consist of grain-fallow, alfalfa-grain-fallow, grass-grain-fallow, or a combination of alfalfa, and grass followed by grain and fallow.

These soils can be farmed in a wheat-fallow rotation without excessive erosion if waterways are shaped and seeded to grass, if stubble-mulch tillage is used, if all tillage is on the contour, and if fall grain is seeded early. Diversion terracing (fig. 6) or stripcropping is needed to control erosion where the slopes are longer than about 350 feet or where the soils lack a cover of grass or legumes. If other soils are upslope from these soils, diversions are needed in places to intercept runoff. Chiseling or subsoiling to a depth of 10 to 24 inches every crop year helps to break up the very hard upper part of the subsoil of the Spofford soils. Chiseling or subsoiling also permits deeper penetration of moisture in winter and slows runoff in spring.

Growing grass or legumes in the rotation helps to control erosion and to maintain or improve tilth. When plowing out a crop of grass or legumes, the plow furrow should be turned uphill.

CAPABILITY UNIT IVe-6

This unit consists of well-drained soils of the Asotin and Spofford series. One of the Asotin soils is mapped separately, but the Spofford soil is mapped only in a complex with an Asotin soil. Where the soils are mapped as a complex, the Asotin soil makes up about 75 percent of the acreage and the Spofford soil makes up about 25 percent. The Spofford soil occurs as roughly circular slickspots that range from 10 to 30 feet in diameter. The Asotin soils are 23 to 38 inches deep to basalt bedrock. Sloes range from 0 to 25 percent. The annual precipitation ranges, from 16 to 20 inches. The frost-free season is 135 to 145 days.

Permeability is moderate to slow, and the soils hold 3 to 8 inches of water that plants can use. Normally, surface runoff is medium to rapid and the hazard of water erosion is moderate to severe. If the ground is frozen, however, runoff is rapid and water erosion is severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, grass, and legumes are the principal crops. They are commonly grown in rotations that consist of grain-fallow, legumes-grain-fallow, grass-grain-fallow, or a combination of legumes and grass followed by grain and fallow. An example of a suitable rotation is 3 to 5 years of grass or legumes, or a combination of grass and legumes, followed by 3 to 5 years of grain-fallow.

These soils can be safely farmed in a grain-fallow rotation without excessive erosion if a winter cover crop is grown or stubble is left standing through the winter, if tillage is on the contour or across the slope, if all crop residue is returned to the soil, if fall grain is seeded early enough to provide winter cover, and if waterways are shaped and seeded to grass. Diversions or stripcropping are needed to control erosion where the slopes are longer than about 250 feet or where the soils lack a cover of grass or legumes. If other soils are upslope, diversions are needed in places to intercept runoff and dispose of it safely because the soils of this unit are moderately shallow. Chiseling to a depth of 10 to 20 inches may be needed every crop year to loosen the subsoil of the Spofford soil. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring.

Growing grass or legumes in the rotation helps to control erosion and to maintain or improve tilth. When plowing out a crop of grass or legumes, the plow furrow should be turned uphill.

Figure 6.-Diversion terracing on Athena-Spofford silt loams, 0 to 15 percent slopes. Good stubble-mulch tillage is shown above the terrace. This area is in NE1/4 sec. 24, T. 11 N., R. 42 E.

CAPABILITY UNIT IVe-7

This unit consists of Waha silt loam, 15 to 25 percent slopes, a well-drained soil that is 24 to 40 inches deep to basalt bedrock. The annual precipitation ranges from 20 to 24 inches. The frost-free season is 115 to 135 days.

Permeability is moderately slow, and the soil holds 5 to 8 inches of water that plants can use. Normally, surface runoff is medium to rapid and the hazard of water erosion is moderate to severe. If the ground is frozen, however, runoff is very rapid and water erosion is very severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Wheat, barley, grass, and legumes are the principal crops. These crops are commonly grown in rotations that consist of grain-fallow, grass-grain-fallow, legumes-grain-fallow, or a combination of grass and legumes followed by grain and fallow.

This soil cannot be safely farmed in a. grain-fallow rotation. It is moderately shallow and should have a cover of vegetation during periods when runoff can cause severe water erosion. Erosion can be controlled if the fall-seeded crop provides sufficient soil cover or stubble is left standing through the winter, if tillage is on the contour or across the slope, if all crop residue is returned to the soil, and if waterways are shaped and seeded to grass. Diversions or stripcropping is needed to control erosion where the slopes are longer than about 200 feet. If other soils are upslope, diversions are needed in places to intercept runoff and dispose of it safely before it reaches this soil. Chiseling to a depth of more than 10 inches may be needed every second or third crop to break tillage pans. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring.

CAPABILITY UNIT IVe-8

This unit consists of Larkin silt loam, 15 to 25 percent slopes, a well-drained soil that is more than 40 inches deep to bedrock. The annual precipitation ranges from 22 to 30 inches. The frost-free season is 100 to 120 days.

Permeability is moderately. slow, and the soil holds 8 to 11 inches of water that plants can use. Normally, surface runoff is medium to rapid and the hazard of water. erosion is moderate to severe. If the ground is frozen, however, runoff is very rapid and water erosion is very severe during rainfall or snowmelt. The hazard of wind erosion is slight.

Most of the acreage is used for woodland. Wheat, barley, grass, and legumes are the principal cultivated

crops. These crops are commonly grown in rotations that consist of grain-fallow, legume-grain-fallow, grass-grain-fallow, or a combination of legumes and grass followed by grain and fallow.

This soil cannot be safely farmed in a grain-fallow rotation. The rotation should include grass or a combination of grass and legumes. An example of a suitable rotation is grass or a combination of grass and legumes for 1 year, a green-manure crop for 1 year, and grain for as long as 3 years. If this rotation is followed, erosion can be controlled if a fall-seeded crop provides sufficient soil cover or stubble is left standing through the winter, if tillage is-on the contour or across the slope, if all crop residue is returned, if fall grain is seeded early, and if waterways are shaped and seeded to grass.

Diversions or stripcropping are needed to control erosion where the slopes are longer than about 200 feet. If other soils are a slope, diversions are needed in places to intercept runoff and dispose of it safely. Chiseling to a depth of more than 10 inches may be needed every second or third crop to break tillage pans. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring.

Drifting snow is common on this soil. The snow smothers fall-seeded grain, permits weeds to invade, and causes excessive rilling or deep slippage of the soil during spring snowmelt. The damage caused by snow can be limited by following the suggested practices or by planting windbreaks to intercept the snow before it reaches this soil.

CAPABILITY UNIT IVe-9

This unit consists of well-drained soils of the Oliphant and Spofford series. These soils are in complexes that consist of about 75 percent Oliphant soils and about 25 percent Spofford soils. The Spofford soils occur as roughly circular slickspots that range from 10 to 30 feet in diameter. All the soils of this unit are more than 40 inches deep to bedrock. Slopes range from 0 to 25 percent. The annual precipitation ranges from 12 to 16 Inches. The frost-free season is 135 to 150 days.

Permeability is moderate to slow, and the soils hold 3 to more than 10 inches of water that plants can use. Surface runoff is medium to rapid, and the hazard of water erosion is moderate to severe.

Wheat, barley, grass, and legumes are the principal crops. They are commonly grown in rotations that consist of grain-fallow, alfalfa-grain-fallow, grass-grain-fallow, or a combination of alfalfa and grass followed by grain and fallow.

These soils can be farmed in a wheat-fallow rotation without excessive erosion if waterways are shaped and seeded to grass, if stubble-mulch tillage is used, if all tillage is on the contour (fig. 7), and if fall grain is seeded early enough to provide winter cover. Diversions or stripcropping are needed to control erosion where the slopes are longer than 350 feet or where the soils lack a cover of grasses or legumes. If other soils are upslope from the soils of this unit, diversions are needed in places to intercept runoff. Chiseling to a depth of 10 to 20 inches may be needed every crop year to break tillage pans. Chiseling also permits deeper penetration of moisture in winter and slows runoff in spring.

Growing grass or legumes in the rotation helps to control erosion and to maintain or improve tilth. When plowing out a crop of grass or legumes, the plow furrow should be turned uphill.

CAPABILITY UNIT VIe-1

This unit consists of well-drained soils of the Asotin, Benge, Chard, Oliphant, and Walla Walla series. The Asotin and Benge soils are 20 to 40 inches deep to bedrock or gravel, and the Chard, Oliphant, and Walla Walla soils are more than 40 inches deep to bedrock. Slopes range from 15 to 55 percent. The annual precipitation ranges from 12 to 16 Inches. The frost-free season is 135 to 155 days.

Permeability is moderate to moderately rapid, and the soils hold 4 to more than 12 inches of water that plants can use. Surface runoff is medium to very rapid, and the hazard of water erosion is moderate to very severe. The hazard of wind erosion is severe on the Chard soil.

The soils of this unit are suitable for grazing. In areas where the slope is less than 40 percent and the range is in poor condition, the soil can be cultivated to a limited extent in order to prepare a seedbed for perennial grasses.

CAPABILITY UNIT VIe-2

This unit consists of well-drained soils of the Asotin, Athena, and Waha series. The Asotin and Waha soils are 20 to 40 inches deep to bedrock, and the Athena soils are more than 40 inches deep to bedrock. Slopes range from 25 to 55 percent. The annual precipitation ranges from 16 to 24 inches. The frost-free season is 115 to 155 days.

Permeability is moderate to moderately slow, and the soils hold 5 to about 12 inches of water that plants can use. Surface runoff is rapid to very rapid, and the hazard of water erosion is severe to very severe. The hazard of wind erosion is slight.

Most of the acreage of these soils is used for grazing, but grass and legumes are grown in small areas where the soils are less steep. The soils should be kept under permanent grass cover to control water erosion. Cultivation should be limited to establishment of grass in areas where the slope is less than 40 percent.

CAPABILITY UNIT VIe-3

This unit consists of well-drained soils of the Larkin and Tolo series. These soils are more than 40 inches deep to bedrock. Slopes range from 10 to 60 percent. The annual precipitation ranges from 22 to 30 inches. The frost-free season is 100 to 120 days.

Permeability is moderate to moderately slow, and the soils hold 8 to 12 inches of water that plants can use. Surface runoff is medium to very rapid, and the hazard of water erosion is moderate to very severe. The hazard of wind erosion is slight.

The soils of this unit are used for woodland and limited grazing.

CAPABILITY UNIT VIIe-1

This unit consists of Quincy loamy fine sand, an excessively drained soil that is more than 60 inches deep to bedrock or gravel. Slopes range from 0 to 25 percent. The annual precipitation ranges from 12 to 16 Inches. The frost-free season is 135 to 155 days.

Permeability is rapid, and surface runoff is slow. The hazard of wind erosion is severe.

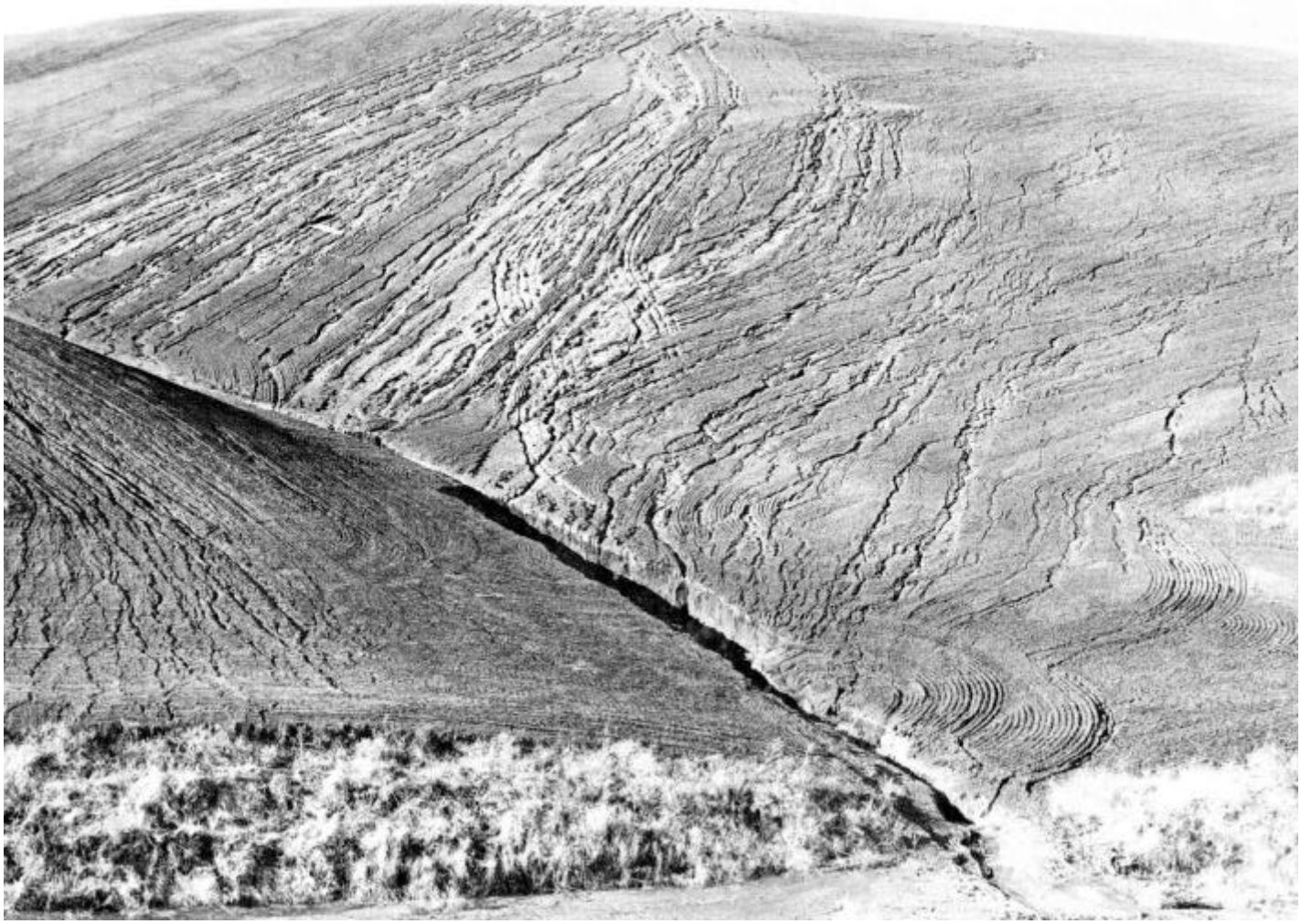

Figure 7-Erosion caused by farming up and down the slopes. Farming on the contour would have eliminated moat of this erosion. This is an area of Oliphant-Spofford silt loams, 15 to 25 percent slopes. It is in SE1/4 sec. 12, T. 12 N., N. 41 E.

Some areas of this soil can be farmed under irrigation. In most of these irrigated areas, grasses and legumes are grown for permanent hay and pasture. The surface should never be completely bare, because the hazard of wind erosion is so severe. The soil is used for native pasture in areas that are not irrigated.

CAPABILITY UNIT VIIe-2

This unit consists of Linville silt loam, 40 to 65 percent slopes, a well-drained soil that is more than 60 inches deep to bedrock. Slopes range from 40 to 65 percent. The annual precipitation ranges from 16 to 20 inches. The frost-free season is 120 to 140 days.

Permeability is moderate, and the soil holds 10 to 12 inches of water that plants can use. Surface runoff is very rapid, and the hazard of water erosion is very severe. The hazard of wind erosion is slight.

The soil in this unit is used for native pasture. It is not suitable for cultivation, because it is too steep.

CAPABILITY UNIT VIIw-1

This unit consists of Henningsen cobbly silt loam, a somewhat poorly drained soil that is 20 to 30 inches deep to waterworn gravel, cobblestones, and stones. Slopes range from 0 to 5 percent. The annual precipitation ranges from 12 to 20 inches. The frost-free season is 120 to 155 days.

Permeability below the surface layer is very rapid, and the soil holds 3 to 4 inches of water that plants can use. Surface runoff is slow, and the hazard of water erosion is slight. The soil is occasionally flooded, and streambank cutting is a moderate hazard. The water table rises to within 4 to 6 feet of the surface during spring runoff. The hazard of wind erosion is slight.

This soil is used for recreation and wildlife habitat. Tillage is very difficult because the surface layer is cobbly. Farming is not economical, even if the soil is irrigated.

CAPABILITY UNIT VIIs-1

This unit consists of well-drained soils of the Alpowa, Anders, Bakeoven, and Lickskillet series and of Rock outcrop. The Alpowa soils are more than 40 inches deep to bedrock, the Anders soil is 20 to 40 inches deep, the Bakeoven soil is 4 to 12 inches deep, and the Lickskillet soil is 10 to 20 inches deep. Slopes range from 10 to 65 percent. The annual precipitation ranges from 12 to 16 inches. The frost-free season is 135 to 155 days.

Permeability is moderate to moderately rapid, and the soils hold 1 to 7 inches of water that plants can use. The hazard of water erosion is slight to very severe, and the hazard of wind erosion is slight.

The soils of this unit are used for range. They are too steep or too shallow for cultivation.

CAPABILITY UNIT VIIs-2

This unit consists of well-drained soils of the Anatone and Gwin series and of Rock outcrop. These soils are 10 to 20 inches deep to basalt bedrock. Slopes range from 10 to 50 percent. The annual precipitation ranges from 16 to 30 inches. The frost-free season is 110 to 140 days.

Permeability is moderate to moderately slow above the bedrock, and the soils hold about 2 inches of water that plants can use. Surface runoff is rapid to very rapid, and the hazard of water erosion is moderate to very severe.

The soils of this unit are used for grazing.

CAPABILITY UNIT VIIs-3

This unit consists of well-drained soils of the Klicker series and of Rock outcrop. The areas occur as complexes that consist of about 85 percent Klicker soils and about 15 percent Rock outcrop. Slopes range from 5 to 50 percent. The annual precipitation ranges from 22 to 30 inches. The frost-free season is 100 to 120 days.

Permeability is moderately slow, and the soils hold 2 to 6 inches of water that plants can use. Normally, surface runoff is slow to rapid and the hazard of water erosion is slight to severe. If the ground is frozen, however, runoff is very rapid and the hazard of water erosion is very severe during rainfall or snowmelt. The hazard of wind erosion is slight.

The soils of this unit are used for woodland and for grazing. If timber has been cleared from these areas, suitable native grasses should be established to protect the soil from erosion. The soils are not suitable for cultivation.

CAPABILITY UNIT VIIIw-1

This unit consists of Riverwash, a land type along the Snake River and small streams. The areas consist of nearly level bars of coarse sand, gravel, and cobblestones. They are generally less than 3 feet above the normal level of streams. Areas of Riverwash are subject to change in size and position, even during normal streamflow.

Riverwash is used for recreation and for wildlife habitat. It is not suitable for cultivation or for grazing.

Estimated Yields

The Garfield County Area has many kinds of soil and a wide range in precipitation from one part of the survey area to another. The influence of these factors on crop yields is great.

Table 2 gives estimated yields per acre of the crops commonly grown on arable soils in the survey area. Soils used mainly for range or woodland are not listed in the table. The estimates are based on average yields for a period of time. In any given year the yields may be considerably higher or considerably lower than the average.

The estimates given in the table are based on the experience of farmers and on observations made by soil scientists and other farm workers who are familiar with the soils and the crops of the survey area. The use of improved crop varieties and the addition of fertilizer, based on the results of soil tests, are a part of the management practices followed by most farmers.

Use of the Soils for Range

Approximately 135,000 acres, or about 35 percent, of the Garfield County Area is used for range (fig. 8). Soils used for range are generally those that are extremely stony or very stony and in most places are steep or very steep. Most of the farms include areas of soils that are better suited to range than to other uses.

Effective range management requires knowledge of the capabilities of the different kinds of soil and the kinds and amounts of herbage that can be produced. Soils that are capable of producing about the same kinds and amounts of forage plants are placed in groups called range sites. The names of the range sites reflect readily recognized physical features of the soils and thus help farmers and ranchers to identify the different kinds of range.

A range site is a distinctive kind of rangeland that differs from other kinds in its potential to produce native plants suitable for grazing. Soil factors that cause such differences are mainly depth of the soil, texture, wetness, soil reaction, exposure, and elevation. Important climatic conditions are the amount of moisture received, temperature, sunlight, and wind conditions.

Range condition refers to the composition of the existing native vegetation on a given site in relation to what the site is capable of producing. It is expressed in terms of condition classes. The condition class represents the degree to which the existing plant community is different from that of the potential plant community.

The range is in excellent condition if 76 to 100 percent of the stand consists of the potential plant community. It is in good condition if the percentage is between 51 and 75, in fair condition if the percentage is between 26 and 50, and in poor condition if it is 25 or less.

The description of each range site gives significant soil characteristics, lists the principal plants, and gives information about use and management. Additional information can be obtained from local offices of the Soil Conservation Service.

The names of the soil series represented are mentioned in the description of each range site, but the listing of the series name does not necessarily indicate that all the soils of that series are in the same site. Soils that are used entirely for cultivated crops and those that are not suitable for grazing have not been placed in a. range site.

[2] ***DEWAYNE BECK,*** **range conservationist, Soil Conservation Service, assisted in writing this section.**

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

The range site for any given soil can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

LOAMY RANGE SITE, 12 TO 16 INCHES PRECIPITATION

This range site consists of soils of the Alpowa, Anders, Asotin, Benge, Chard, Oliphant, and Walla Walla series. It makes up approximately 21,300 acres. Most of the areas are in the northwestern part of Garfield County, but a small area is in the east-central part. These are well-drained soils on uplands, terraces, outwash plains, canyon side slopes, and foot slopes. Exposures are generally south and west. Slopes range from 5 to 40 percent. Elevations range from 600 to 2,500 feet.

The annual precipitation is 12 to 16 inches. About 80 percent of this moisture is received between October 1 and June 1. The summers are hot and dry. The period between April 1 and June 15 is favorable for the growth of native plants. There is some extra loss of moisture by evaporation because of wind and direct sunlight.

Permeability is moderate in the Anders, Asotin, Oliphant, and Walla Walla soils. It is moderate to moderately rapid in the Alpowa and Chard soils and moderate to very rapid in the Benge soils.

In the potential plant community, bluebunch wheatgrass makes up 50 percent of the vegetation, by weight, and Idaho fescue and big bluegrass together make up 20 percent. The rest of the potential plant community con-

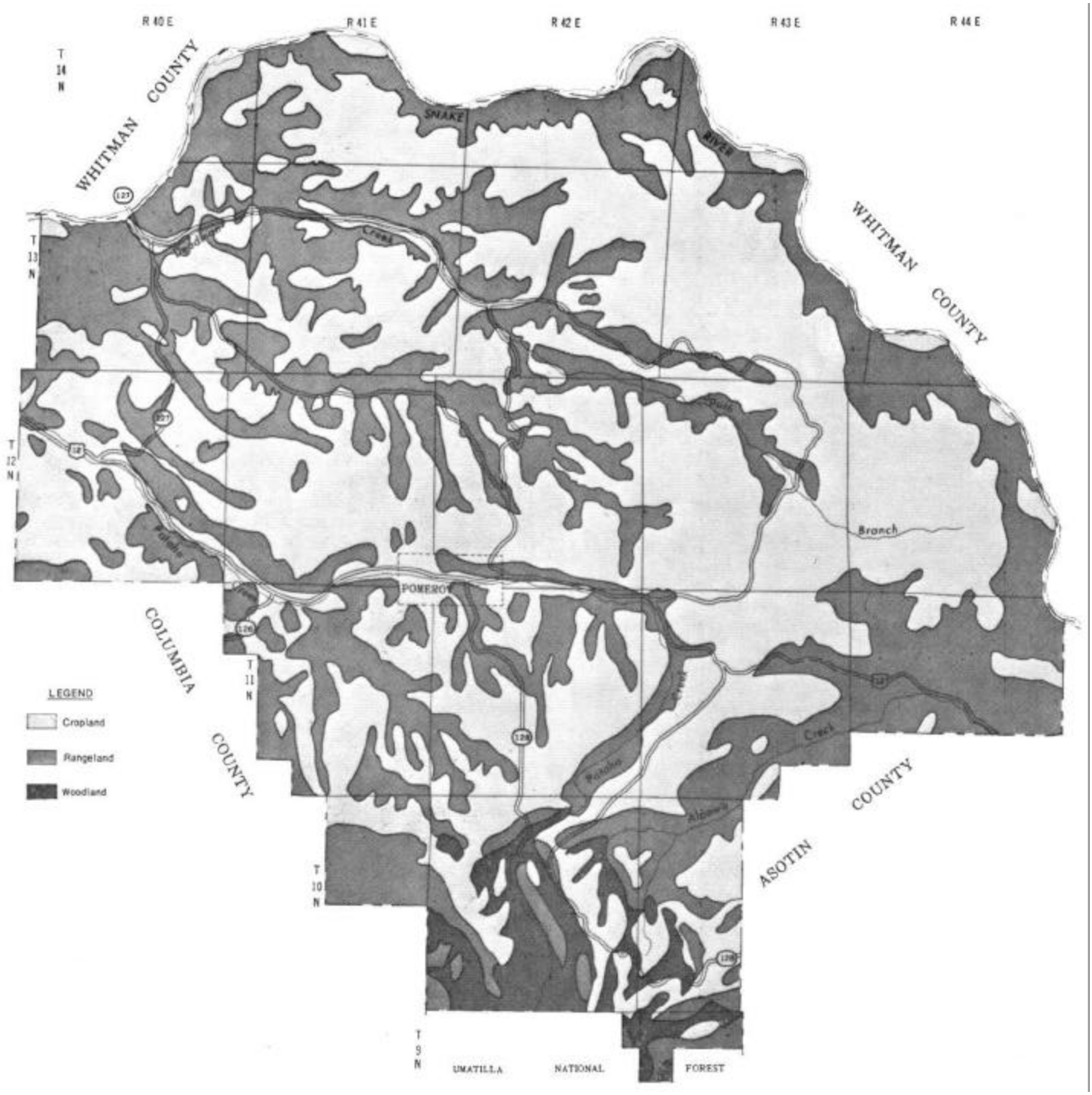

Figure 8.-General pattern of rangeland, cropland, and woodland in the Garfield County Area.

sists of Sandberg bluegrass, prairie junegrass, threadleaf sedge, giant wildrye, milkvetch, arrowleaf balsamroot, aster, gromwell, buckwheat, lupine, hawksbeard, gray rabbitbrush, and phlox.

If this site is in excellent condition, the total production is about 1,400 pounds, air dry, per acre in years when growing conditions are favorable and 700 pounds per acre in years when growing conditions are unfavorable. About 90 percent of this production is plants that provide forage for cattle and sheep: The site is most suitable for livestock grazing in spring and early in summer, or late in fall. It provides grazing for big game animals late in fall, in winter, and early in spring.

Bluebunch wheatgrass, Idaho fescue, big bluegrass, giant wildrye, and prairie junegrass decrease under heavy grazing or repeated burning. Threadleaf sedge, Sandberg

bluegrass, lupine, and phlox are major increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include cheatgrass brome, yellow star-thistle, medusahead wildrye, plantain, mustard, thistle, and mullein.

Seeding should be considered if the pasture is in poor condition. A summer fallow seedbed is best, but direct seeding with a heavy-duty range drill is being tried on an experimental basis. Most of the soils in this site are suitable for seedbed preparation and for seeding perennial forage plants with either a grass drill or a grain drill. It is important to select kinds of grasses for seeding that provide forage for the desired period of use and that protect the soils from erosion.

NORTH EXPOSURE RANGE SITE, 12 TO 16 INCHES PRECIPITATION

This range site consists of soils of the Alpowa, Oliphant, and Walla Walla series. It makes up approximately 14,000 acres. Most of the areas are in the northwestern part of Garfield County, but a. small area is in the east-central part. These are well-drained soils. Exposures are north or northeast. Elevations range from 600 to 3,000 feet.

The annual precipitation is 12 to 16 inches. About 80 percent of this moisture is received between October 1 and June 1. The accumulation of snow that is blown from adjacent ridgetops adds to the moisture supply, and protection from wind and direct. sunlight limits the loss of moisture by evaporation. The summers are hot and dry, but the northerly exposures provide conditions that encourage plant growth. The period between April 15 and July 1 is favorable for the growth of native plants.

Permeability is moderate in the Oliphant and Walla, Walla soils. It is moderate to moderately rapid in the Alpowa soils.

In the potential plant community, Idaho fescue makes up 55 percent, by weight, of the vegetation, bluebunch wheatgrass and prairie junegrass together make up 15 percent, and lupine, arrowleaf balsamroot, sand biscuitroot together make up 10 percent. The rest of the potential plant community consists of Sandberg bluegrass, silene, pussytoes, hawksbeard, cinquefoil, stoneseed, yarrow, paintbrush, fleabane, buckwheat, gray rabbitbrush, and phlox.

If this site is in excellent condition, the total production is about 1,600 pounds, air dry, per acre in years when growing conditions are favorable and 750 pounds per acre in years when growing conditions are unfavorable. About 85 percent of this production is plants that provide forage for cattle and sheep. This site provides grazing for livestock and big game late in spring, in summer, and in fall.

Idaho fescue, bluebunch, wheatgrass, and prairie junegrass decrease under heavy grazing or repeated burning. Sandberg bluegrass, lupine, arrowleaf, balsamroot, cinquefoil, yarrow, buckwheat, phlox, and rabbitbrush are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include cheatgrass brome, medusahead wildrye, annual fescue, yellow star-thistle, mullein, plantain, and bull-thistle.

Seeding should be considered if the site is in poor condition. It is important to select kinds of grasses for seeding that provide forage for the desired period of use and that protect the soils from erosion. Chemical control of weeds encourages the establishment of a. good stand of grass.

LOAMY RANGE SITE, 16 TO 24 INCHES PRECIPITATION

This range site consists of soils of the Asotin, Athena, Spofford, and Waha series. It makes up approximately 9,900 acres. These are well-drained soils on uplands. Slopes range from 0 to 40 percent. Elevations range from 1,850 to 4,500 feet.

The annual precipitation is 16 to 24 inches. About 80 percent of this moisture is received between October 1 and June 1. The summers are warm and dry. The period between May 1 and July 15 is favorable for the growth of native plants.

Permeability is moderate in the Athena and Asotin soils. It is slow in the Spofford soil and moderately slow in the Waha soil.

In the potential plant community, bluebunch wheatgrass makes up 40 percent of the vegetation, by weight, and Idaho fescue and prairie junegrass together make up 25 percent. The rest of the potential plant community consists of Sandberg bluegrass, big bluegrass, giant wildrye, Columbia needlegrass, Canada bluegrass, Kentucky bluegrass, lupine, arrowleaf balsamroot, fleabane, biscuitroot, buckwheat, phlox, hawthorn, serviceberry, snowberry, and rose.

If this site is in excellent condition, the total production is about 2,400 pounds, air dry, per acre in years when growing conditions are favorable and 1,000 pounds per acre in years when growing conditions are unfavorable. About 90 percent of this production is plants that provide forage for cattle and sheep and big game. This site provides grazing late in spring, in summer, and in fall. It also provides cover for wildlife.

Bluebunch wheatgrass, Idaho fescue, big bluegrass, and prairie junegrass decrease under heavy grazing or repeated burning. Canada bluegrass, Kentucky bluegrass. Sandberg bluegrass, lupine, balsamroot, biscuitroot, snowberry, and rose are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include cheatgrass brome, Japanese brome, medusahead wildrye, prickly lettuce, yellow star-thistle, St.-Johns-wort, knapweed, Russian-thistle, and rabbitbrush.

Seeding should be considered if the site is in poor condition. All the soils of this site are suitable for seedbed preparation and for seeding perennial forage plants with either a grass drill or a grain drill. A mixture of rice or pea hulls and grass seed is used in the grain drill. It is important to select kinds of grasses for seeding that provide forage for the desired period of use and that protect the soils from erosion.

NORTH EXPOSURE RANGE SITE, 16 TO 20 INCHES PRECIPITATION

This range site consists of soils of the Athena and Linville series. It makes up approximately 17,600 acres. These are well-drained, moderately permeable soils. Exposures are north and east. Elevations range from 1,100 to 3,400 feet.

The annual precipitation is 16 to 20 inches. About 80 percent of this moisture is received between October 1 and June 1. The accumulation of snow that is blown from

adjacent ridgetops adds to the moisture supply, and protection from wind and direct sunlight limits the loss of moisture by evaporation. The summers are warm and dry. The period between May 10 and July 30 is favorable for the growth of native plants.

In the potential plant community, Idaho fescue makes up 65 percent, by weight, of the vegetation. The rest of the potential plant community consists of bluebunch wheatgrass, prairie junegrass, big bluegrass, Sandberg bluegrass, elk sedge, Kentucky bluegrass, sticky geranium, hawkweed, aster, lupine, cinquefoil, yarrow, pussytoes, fleabane, milkvetch, balsamroot, rose, snowberry, currant, ninebark, phlox, buckwheat, serviceberry, chokecherry, and scattered ponderosa pine.

If this site is in excellent condition, the total production is about 2,000 pounds, air dry, per acre in years when growing conditions are favorable and 1,500 pounds per acre in years when growing conditions are unfavorable. About 80 percent of this production is plants that provide forage for cattle and sheep. This site is most suitable for livestock grazing in summer and in fall. It provides grazing for big game animals in all seasons.

Idaho fescue, bluebunch wheatgrass, and big bluegrass decrease under heavy grazing or repeated burning. Sandberg bluegrass, Kentucky bluegrass, balsamroot, lupine, phlox, rose, fleabane, and snowberry are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include cheatgrass brome, medusahead wildrye, mustard, thistles, and St. Johns-wort.

Seeding should be considered if the site is in poor condition. It is important to select kinds of grasses for seeding that provide forage for the desired period of use and that protect the soils from erosion. Chemical control of weeds encourages the establishment of a good stand of grass.

NORTH EXPOSURE RANGE SITE, 20 TO 24 INCHES PRECIPITATION

This range site consists only of Palouse silt loam, moderately shallow, 25 to 40 percent slopes. It makes up approximately 400 acres in the southern part of the survey area, just north of the Umatilla National Forest. This soil is well drained and moderately permeable. Exposures are north and east. Elevations range from 3,000 to 4,500 feet.

The annual precipitation is 20 to 24 inches. About 80 percent of this moisture is received between October 1 and June 1. The accumulation of snow that is blown from adjacent ridgetops adds to the moisture supply, and protection from wind and direct sunlight limits the loss of moisture by evaporation. The additional moisture lengthens the growing season. The summers are warm and dry. The period between May 15 and July 30 is favorable for the growth of native plants.

In the potential plant community, Idaho fescue, elk sedge, and pinegrass together make up 40 percent of the vegetation, by weight. The rest of the potential plant community consists of bluebunch wheatgrass, big bluegrass, Kentucky bluegrass, mountain brome, blue wildrye, silene, aster, hawkweed, geranium, balsamroot, lupine, arnica, phlox, vetch, pearly everlasting, strawberry, rose, snowberry, serviceberry, spirea, ocean-spray, chokecherry, hawthorn, ninebark, willow, and maple. The site also supports scattered ponderosa pine and Douglas-fir.

If this site is in excellent condition, the total production is about 2,600 pounds, air dry, per acre in years when growing conditions are favorable and 2,000 pounds per acre in years when growing conditions are unfavorable. About 85 percent of this production is plants that provide forage or browse for cattle anal sheep, as well as for big game animals. This site is most suitable for livestock grazing and wildlife habitat in summer and in fall. It provides food for wildlife in winter.

Idaho fescue, elk sedge, and bluebunch wheatgrass decrease under heavy grazing or repeated burning. Kentucky bluegrass, lupine, strawberry, cinquefoil, snowberry, currant, rose, ninebark, and spirea are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include cheatgrass brome, medusahead wildrye, mustard, yellow star-thistle, St.-Johns-wort, stonecrop, thistle, and gray rabbitbrush.

Seeding should be considered if the site is in poor condition. Brush control is generally needed before seeding, but the usefulness of the brush for wildlife habitat and shade for livestock should also be considered. It is important to select kinds of grasses for seeding that provide forage for the desired period of use and that protect the soils from erosion.

SANDY RANGE SITE, 12 TO 16 INCHES PRECIPITATION

This range site consists of Quincy loamy fine sand. It makes up approximately 400 acres on sandy terraces along the Snake River in the northern part of Garfield County. This soil is excessively drained and rapidly permeable. It is undulating to moderately steep. Elevations range from 600 to 800 feet.

The annual precipitation is 12 to 16 inches. Most of this moisture is received between October 1 and May 1. This is a dry site, mainly because moisture is lost through percolation and evaporation. The summers are hot and dry. The period between March 15 and June 1 is favorable for the growth of native plants.

In the potential plant community, needle-and-thread makes up 70 percent of the vegetation, by weight. The rest of the potential plant community consists of Sandberg bluegrass, sand dropseed, thickspike wheatgrass, prairie junegrass, Indian ricegrass, sand-dune ryegrass, wild buckwheat, fleabane, balsamroot, scurf-pea, sand dock, yarrow, dog parsley, evening primrose, prickly pear, phlox, gray rabbitbrush, and antelope bitterbrush.

If this site is in excellent condition, the total production is about 1,000 pounds, air dry, per acre in years when growing conditions are favorable and 500 pounds per acre in years when growing conditions are unfavorable. About 90 percent of this production is plants that provide forage for cattle and sheep. This site is most suitable for grazing late in fall, in winter, and early in spring when the soil is moist. The soil is loose and sandy, and for this reason, grazing animals should be excluded in summer when the soil is dry because trampling causes severe damage and increases the hazard of wind erosion.

Needle-and-thread, Indian ricegrass, prairie junegrass, sand dropseed, thickspike wheatgrass, dog parsley, and antelope bitterbrush decrease under heavy grazing or repeated burning. Sandberg bluegrass, phlox, yarrow, and rabbitbrush are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates.

These invaders include cheatgrass brome, cocklebur, prickly lettuce, plantain, sandbur, and ragweed.

Seeding should be considered if the site is in poor condition, but cultivation should be kept to a minimum. Alternate strip seeding may help to reduce the hazard of wind erosion. It is important to select kinds of grasses for seeding that, provide forage for the desired period of use and that protect the soils from erosion.

SHALLOW RANGE SITE, 12 TO 16 INCHES PRECIPITATION

This range site consists of soils of the Lickskillet series. It makes up approximately 28,900 acres. Most of the areas are in the northwestern part of Garfield County, but a small area is in the east-central part. These are well-drained, moderately permeable, level to very steep soils. The depth to basalt bedrock ranges from 10 to 20 inches. Exposures are south and west. Elevations range from 600 to 3,000 feet.

The annual precipitation is 12 to 16 inches. About 80 percent of this moisture is received between October 1 and June 1. This is a dry site, and plant growth is limited by the shallowness of the soil and the loss of moisture through evaporation caused by wind and direct sunlight. The summers are hot and dry. The period between April 1 and June 1 is favorable for the growth of native plants.

In the potential plant community, bluebunch wheatgrass makes up 65 percent of the vegetation, by weight, and Sandberg bluegrass makes up 10 percent. The rest of the potential plant community consists of Thurber needlegrass, arrowleaf balsamroot, biscuitroot, fleabane, lupine, yarrow, phlox, eriogonum, carrotleaf, rabbitbrush, and shrubby eriogonum.

If this site is in excellent condition, the total production is about 700 pounds, air dry, per acre in years when growing conditions are favorable and 400 pounds per acre in years when growing conditions are unfavorable. About 90 percent of this production is plants that provide forage for cattle and sheep and big game animals. The site is most suitable for grazing in spring, and in fall or winter. Grazing animals must be periodically excluded, however, in order to maintain or improve range condition.

Bluebunch wheatgrass and Idaho fescue decrease under heavy grazing or repeated burning. Sandberg bluegrass, needle-and-thread, Thurber needlegrass, biscuitroot, and rabbitbrush are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include cheatgrass brome, Russian-thistle, prickly lettuce, yellow star-thistle, and medusahead wildrye.

Seeding should be considered if the site is in poor condition. Seeding with a heavy-duty range drill is being tried on an experimental basis. It is important to select kinds of grasses for seeding that provide forage for the desired period of use and that protect the soils from erosion. Chemical spraying of weeds or controlled burning encourages the establishment of a good stand of grass.

SHALLOW RANGE SITE, 16 TO 24 INCHES PRECIPITATION

This range site consists of soils of the Anatone and Gwin series. It makes up approximately 35,900 acres. The areas are throughout the county. These are well-drained soils that are moderately permeable to moderately slowly permeable. The depth to basalt bedrock ranges from 10 to 20 inches. Slopes are 10 to 50 percent. Exposures are south and west. Elevations range from 1,900 to 4,500 feet.

The annual precipitation is 16 to 24 inches. About 80 percent of this moisture is received between October 1 and June 30. This is a dry site, and plant growth is limited by .the shallowness of the soil and the loss of moisture through evaporation caused by wind and direct sunlight. The summers are warm and dry. The period between May 1 and July 15 is favorable for the growth of native plants.

In the potential plant community, bluebunch wheatgrass makes up 45 percent of the vegetation, by weight, Idaho fescue makes up 25 percent, and Sandberg bluegrass and squirreltail together make up 15 percent. The rest of the potential plant community consists of biscuitroot, serrated balsamroot, arrowleaf balsamroot, fleabane, paintbrush, and lupine.

If this site is in excellent condition, the total production is about 1,200 pounds, air dry, per acre in years when growing conditions are favorable and 500 pounds per acre in years when growing conditions are unfavorable. About 90 percent of this production is plants that provide forage for cattle and sheep and big game animals. The site is most suitable for grazing in spring.

Bluebunch wheatgrass and Idaho fescue decrease under heavy grazing or repeated burning. Sandberg bluegrass, squirreltail, balsamroot, biscuitroot, lupine, and buckwheat are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include cheatgrass brome, Japanese brome, medusahead wildrye, prickly lettuce, thistle, yellow star-thistle, and big sagebrush.

Seeding should be considered if the site is in poor condition. Seeding with a heavy-duty range drill is being tried on an experimental basis. It is important to select kinds of grasses for seeding that provide forage for the desired period of use and that protect the soils from erosion. Chemical spraying of weeds encourages the establishment of a good stand of grass.

VERY SHALLOW RANGE SITE, 12 TO 16 INCHES PRECIPITATION

This site consists only of the Bakeoven part (fig. 9) of the Lickskillet-Bakeoven complex, 10 to 50 percent slopes. It makes up approximately 6,900 acres. This is a well-drained to somewhat excessively drained soil that is moderately permeable. The depth to basalt bedrock is less than 12 inches. Exposures are south and west. Elevations range from 600 to 3,000 feet.

The annual precipitation is 12 to 16 inches. Most of this moisture is received between October 1 and June 1. The summers are hot and dry. The period between April 1 and May 15 is favorable for the growth of native plants.

In the potential plant community, Sandberg bluegrass makes up 50 percent of the vegetation, by weight, stiff sagebrush makes up 20 percent, and shrubby eriogonum makes up 15 percent. The rest of the potential plant community consists of bluebunch wheatgrass, Thurber needlegrass, squirreltail, narrowleaf goldenweed, fleabane, biscuitroot, serrated balsamroot, penstemon, and violet.

If this site is in excellent condition, the total production is about 300 pounds, air dry, per acre in years when growing conditions are favorable and 175 pounds per acre in years when growing conditions are unfavorable.

Figure 9.-An area of Very Shallow range site in excellent condition. The soil is Bakeoven extremely stony silt loam, a part of the Lickskillet-Bakeoven complex, 10 to 50 percent slopes. In the background is a southerly view of the Tucannon River breaks in Columbia County. This area is in SW1/4 sec. 7, T. 11 N., R. 41 E.

About 70 percent of this production is plants that provide forage for cattle, sheep, deer, and elk. The site is most suitable for grazing by livestock early in spring and for grazing by game animals during the dry season and in winter.

Sandberg bluegrass and stiff sagebrush decrease under heavy grazing or repeated burning. Serrated balsamroot, biscuitroot, and phlox are increasers. Undesirable weeds and annuals invade the site if the range condition deteriorates. These invaders include yellow star-thistle, cheatgrass brome, and medusahead wildrye.

Seeding is not feasible, because the soil is too shallow and stony and potential yields are too low.

Use of the Soils for Woodland and Windbreaks

The Garfield County Area consists of all of Garfield County except those lands that form part of the Umatilla National Forest. The national forest covers all of the southern part of the county.

[3] ROBERT J. OLSON, woodland specialist, Soil Conservation Service, assisted with preparation of this section.

Some 10,800 acres, or about 3 percent of the survey area, is used for forest. The areas are privately owned. The important lumber species are ponderosa pine, Douglas-fir, western larch, and grand fir. The principal woodland products are lumber and some pulpwood. Wood products are shipped to mills outside the county. Corral posts and poles of western larch or lodgepole pine are also in demand.

Woodlands in this survey area are also used for grazing, recreation, wildlife habitat, and watershed protection.

Management by woodland groups

Management of woodland can be planned more effectively if the soils are grouped according to those characteristics that affect tree growth and the management of the stands. For this reason the soils of the Garfield County Area, have been placed in three woodland groups. Each group consists of soils that have about the same suitability for trees, require about the same management, and have about the same potential productivity.

The potential productivity for woodland is the estimated yield of each forest type or single species that a

given soil can produce. The site index is the most common measurement of this potential. Site index is a numerical means of expressing the quality of a forest site that is based on the average height, in feet, attained by the dominant and codominant trees in a fully stocked stand at the age of 100 years. Table 3 gives the estimated yields of unmanaged, fully stocked stands of ponderosa pine (4) by the site index. This can be used as an indication of the production of other species listed in this soil survey.

Woodland site indexes may be grouped into site classes for broader interpretations. Site class 1 is excellent and indicates high productivity; site class 5 is poor and indicates low productivity. Site class 1 has a site index of 113 or more; site class 2, 99 to 112 ; site class 3, 85 to 98 ; site class 4, 71 to 84; and site class 5, 57 to 70. Site classes 1 and 5 are not represented in this survey area.

The numeral in the symbol for woodland groups indicates the site class. The lower case letter indicates the subclass. This letter indicates an important soil property that imposes a slight to severe limitation in managing the soils of the group for wood crops.

Three subclasses in the rating system are represented in this survey area. In *subclass o* are soils that have no significant restrictions or limitations for woodland use or management. In *subclass r* are soils that have restrictions or limitations because of slope. In *subclass d* are soils that have restrictions or limitations because of a shallow rooting zone. Soils that are shallow to hard rock or to soil layers that restrict the penetration of roots are examples.

In the following pages the woodland groups of this survey area are discussed. The names of the soil series represented are mentioned in the description of each woodland group, but the listing of the series name does not necessarily indicate that all the soils of a series are in the same group. The woodland group of any given soil can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

WOODLAND GROUP 2r

This group consists of soils of the Larkin and Tolo series. These are well-drained soils that have a surface layer of silt loam and a subsoil of silty clay loam. They formed over basalt bedrock in volcanic ash and other windblown material. Elevations are about 3,000 to 4,500 feet. The annual precipitation is 22 to 30 inches. The frost-free season is 100 to 120 days.

Ponderosa pine, Douglas-fir, and grand fir are the important commercial species. The growth of brush or other undesirable plants delays the establishment and growth of desirable trees. Grand fir can be more easily established than the other trees where brush competition is prevalent. Ponderosa pine needs more space for regeneration than either Douglas-fir or grand fir. If plant competition is controlled, mortality of both natural and planted seedlings is generally less than 25 percent.

The use of equipment is severely ,restricted because of the slope and the accumulation of snow in winter. Specialized equipment should be used and special methods of operation must be planned to control erosion.

The grazing potential is low. In places these soils provide limited amounts of forage after logging. Suitable grasses and legumes can be seeded in cleared areas for erosion control and grazing.

WOODLAND GROUP 3o

This group consists of soils of the Larkin and Tolo series. These are well-drained soils that have a surface layer of silt loam and a subsoil of silty clay loam. They formed over basalt bedrock in volcanic ash and other windblown material. Elevations are about 3,000 to 4,500 feet. The annual precipitation is 22 to 30 inches. The frost-free season is 100 to 120 days.

Douglas-fir, grand fir, and western larch are the important commercial species. The growth of brush or other undesirable plants delays the establishment and growth of desirable trees. Grand fir can be more easily established than the other trees where brush competition is prevalent. If plant competition is controlled, mortality of both

In the original manuscript, there was a table in this space. All tables have been updated and are available as a separate document.

natural and planted seedlings should be less than 25 percent.

The use of equipment is moderately restricted in the steeper areas. Some care must be used in logging to control erosion in these areas.

The grazing potential varies with the density of the stand (fig. 10). Small openings in the stand are common in some areas. Pruning and thinning encourage the growth of a grazable understory. Suitable grasses can be seeded in open areas for grazing and erosion control.

WOODLAND GROUP 4d

This group consists of Klicker-Rock outcrop complexes. The Klicker soils are well drained and have a surface layer of silt loam and a subsoil of silty clay loam. They formed in a mixture of windblown silty material and residuum weathered from basalt. The depth to basalt bedrock is 20 to 40 inches. Elevations are 3,000 to 4,500 feet. The annual precipitation is 22 to 30 inches. The frost-free season is 100 to 120 days.

Ponderosa pine and Douglas-fir are the important commercial species. The growth of brush or other undesirable plants prevents establishment of new stands of naturally seeded trees or planted seedlings without intensive site preparation. Seedling mortality is generally between 25 and 50 percent.

The use of equipment is moderately restricted. Some care must be used in logging to control erosion. The

Figure 10.-Pruning and thinning the trees in wooded areas encourages growth of a grazable understory. The soil is Larkin silt loam, 0 to 15 percent slopes. This area is in SE1/4 sec 29, T. 10 N., R. 42 E.

hazard of erosion is severe in the steeper areas. Some trees can be expected to be blown down during high winds if the ground is excessively wet.

The grazing potential is medium. The common forage plants are Idaho fescue, bluebunch wheatgrass, and pinegrass. Understory shrubs are ninebark, rose, ocean-spray, and snowberry.

Management by windbreak groups

Most of the survey area was formerly grassland. The suitability of the soils and the climate need to be considered when plantings of trees and shrubs are made for windbreaks, wildlife habitat, recreation, and esthetic value. Table 4 shows the suitability of specified trees and shrubs to the soils of the windbreak groups.

The windbreak groups of the survey area are discussed in the following paragraphs. The names of the soil series represented are mentioned in the description of each windbreak group, but the listing of the series name does not necessarily indicate that all the soils of a. series are in the same group. The windbreak group of any given soil can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

WINDBREAK GROUP 1

This group consists of soils of the Anders and Asotin series. These are well-drained soils that have a. surface layer of silt loam. They are 23 to 38 inches deep over bedrock, and they formed in windblown silty material. Elevations are about 600 to 2,550 feet. The annual precipitation is 12 to 16 inches. The frost-free season is 135 to 155 days.

WINDBREAK GROUP 2

This group consists of well-drained soils of the Asotin, Chard, and Oliphant series. The Asotin soils have a surface layer of silt loam; they are underlain by basalt bedrock at a depth of 23 to 40 inches. The Chard soil has a surface layer of silt loam and a subsoil loam or fine sandy loam. The Oliphant soils have a surface layer of silt loam; they are underlain by basalt bedrock at a depth of 40 to more than 60 inches. Elevations are 600 to 3,400 feet. The annual precipitation is 16 to 20 inches in areas of Asotin soils and 12 to 16 inches in areas of Chard and Oliphant soils. The frost-free season is 135 to 155 days.

WINDBREAK GROUP 3

This group consists of well-drained soils of the Athena, Chard, Hermiston, Oliphant, Onyx, and Walla Walla series (fig. 11) . The Chard, Hermiston, Oliphant, Onyx, and Walla Walla soils are more than 60 inches deep to basalt bedrock. The Athena soils are underlain by basalt bedrock at a depth of 40 to 60 inches. The Chard soils have a surface layer of silt loam and a subsoil of fine sandy loam. Elevations are 600 to 3,400 feet. The annual precipitation is 16 to 20 inches in areas of Athena soils and 12 to 16 inches in areas of all other soils of this group. The frost-free season is 135 to 155 days.

WINDBREAK GROUP 4

This group consists of well-drained soils of the Athena, Mondovi, Palouse, and Waha series. The Athena and Mondovi soils are more than 60 inches deep to bedrock. The Palouse soils are underlain by basalt bedrock at a depth of 40 to 60 inches. The Waha soils are underlain by basalt bedrock at a. depth of 24 to 40 inches. The Athena, Mondovi, and Palouse soils have a surface layer of silt loam. The Waha soils have a surface layer of silt loam and a subsoil of silty clay loam. Elevations are 1,850 to 4,500 feet. The annual precipitation is 16 to 20 inches in areas of Athena and Mondovi soils and 20 to 24 inches in areas of Palouse and Waha soils. The frost-free season is 115 to 145 days.

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

Figure 11.-Farmstead shelterbelt established on Walla Walla silt loam, 7 to 25 percent slopes. This area is in NW1/4 sec. 15, T. 12 N., R. 41 E.

WINDBREAK GROUP 5

This group consists of soils of the Palouse series. These are well-drained soils that have a surface layer of silt loam. They are underlain by basalt bedrock at a depth of 40 to more than 60 inches. Elevations are 3,000 to 4,500 feet. The annual precipitation is 20 to 24 inches. The frost-free season is 125 to 135 days.

WINDBREAK GROUP 6

This group consists only of Palouse silt loam, moderately shallow, 25 to 40 percent slopes. This is a well-drained soil that is underlain by basalt bedrock at a depth of 40 to 60 inches. Elevations are 3,000 to 4,500 feet. The annual precipitation is 20 to 24 inches. The frost-free season is 125 to 135 days.

WINDBREAK GROUP 7

This group consists of very shallow to very deep soils of the Alpowa, Anatone, Anders, Asotin, Athena, Bakeoven, Benge, Chard, Gwin, Henningsen, Lance, Lickskillet, Linville, Oliphant, Quincy, Spofford, Waha, arid Walla Walla series. The land types Rock outcrop and Riverwash are also in this group. Drainage varies widely among these soils. The Benge and Henningsen soils have a surface layer of silt loam and are underlain by sand and gravel at a depth of about 20 to 40 inches. The Chard soils have a surface layer of silt loam and a subsoil of silt loam or fine sandy loam. The Quincy soil is sandy throughout. The Waha and Gwin soils have a surface layer of silt loam and a subsoil of silty clay loam. All other soils in this group are silt loam or loam. Riverwash is mostly sand, gravel, and cobblestones. Elevations are 600 to 4,500 feet. The annual precipitation is 12 to 30 inches. The frost-free season is 115 to 155 days.

Soils of this windbreak group can be used for trees and shrubs only after intensive, special care and site preparation. Only a limited number of trees and shrubs are suited.

Use of the Soils for Wildlife

No two kinds of wildlife have exactly the same needs for their habitat, but all kinds must have food, cover, and water. To support a high wildlife population, a farm or ranch must have a plentiful supply of good food close to cover that gives protection from weather and predators.

Soils used primarily for crops, hay, range, or woodland can be used also to produce wildlife as a secondary crop. In addition, there are small areas on most farms or ranches that can be used primarily for wildlife habitat. Vegetation that provides food and shelter for wildlife also protects the soil from erosion. Proper development and distribution of wildlife areas will make the entire farm or ranch more productive for wildlife.

Populations of wildlife change as land use and cropping practices change. The introduction of farming improves the environment for such speci6s as dove, quail, Hungarian partridge, pheasant, most songbirds, and cottontail rabbits. Squirrels, deer, elk, bear, bobcats, ruffed grouse, blue grouse, and wild turkey defend on woodland. Pheasants need woody cover, especially in winter. Raccoons and porcupines use wooded draws and trees growing along streams. Hawks, eagles, crows, and mag-

pies feed extensively on carrion. These scavengers perform a service for man by removing dead animals from roads and highways.

Most forms of wildlife are beneficial to farmers and ranchers. They help them to produce more crops by controlling insects, weeds, and other pests. Moles, shrews, and bats eat insects. Ground squirrels often feed on insects and their eggs. Skunks and raccoons feed heavily on insects. Larger furbearers are valuable in controlling mice and ground squirrels.

Hunting for deer, elk, turkey, mountain sheep, and upland game birds is one of the main forms of recreation in the survey area, as is fishing for rainbow trout in Baker's Pond or in Alpowa, South Deadman, and Pataha Creeks. Bass, perch, sturgeon, salmon, and steelhead are the major species of fish in the Snake River. Little Goose Dam, recently completed on the Snake River, will have a major effect on fishing and water sports.

Hiking, camping, and hunting deer or elk are popular recreational activities within the boundaries of the Umatilla National Forest, which joins the survey area on the south. The use of snowmobiles has become a popular sport in the national forest, and watching wildlife adds to the enjoyment of the participants.

The suitability of the soils for wildlife habitat can be related in a general way to the six soil associations in this survey area. The associations are described more fully in the section "General Soil Map." The important species of wildlife and their relationship to the soils of each association are discussed in the following paragraphs.

Chard-Lickskillet-Walla Walla association.-About 60 percent of this association consists of extremely stony or very steep soils that are used for range. The areas being farmed have irregular boundaries, and this creates a favorable environment for Hungarian partridge and ring-necked pheasant. Chukars prefer areas of extremely stony soils, where the rock outcrops and very steep slopes provide protection from weather and predators. A few California quail are on the bluffs along the Snake River.

The water supply is limited to perennial streams, a few springs, and stock-watering facilities. Additional watering stations and winter feeding areas are needed to help build up the bird population. Ducks feed arid nest along the perennial streams. Both ducks and geese fly off the Snake River to feed in nearby grainfields.

A few deer are occasionally seen crossing the roads. Coyotes are common, but their numbers fluctuate, largely because of the predator-control program.

Oliphant-Walla Walla-Lickskillet association.-In most places the nearly level to steep areas of this association are being farmed. Soils that are extremely stony or those that are very steep make up the 40 percent of this association that is used for range. The pattern of intermittent cultivated fields and range creates favorable conditions for Hungarian partridge and ring-necked pheasant. Chukars are fairly abundant on the extremely stony soils that face south or west. California quail are along all the perennial streams.

The water supply is limited primarily to perennial streams, a few springs, and stock-watering facilities. A few bird-watering facilities have been installed (fig. 12). These watering stations collect precipitation and hold drinking water to last through the dry weather of spring and summer. They are placed as close as possible to food supply and shelter. Ducks feed and nest along the perennial streams. Both ducks and geese fly off the Snake River to feed in nearby grainfields.

A few deer are scattered throughout the association. Coyotes are numerous.

Athena-Asotin association.-The nearly level to steep areas of this association are being farmed. Soils that are extremely stony, or those that are very steep, make up the 20 percent of the association that is used for range. Most of the cropland is cultivated from fence to fence. Only the grassed waterways offer shelter and nesting places. Areas of range are scattered along the deep drainageways that dissect the cultivated areas. The potential for production of upland game birds is high, but a Significant increase in bird populations would require the seeding of nesting, brooding, and wintering areas on soils that are now being farmed. Hungarian partridge and ring-necked pheasant are numerous where food, shelter, and water are nearby. Chukars are plentiful in extremely stony areas. California quail are near watering facilities and along the perennial streams.

The water supply is from springs, stock-watering facilities, and perennial streams. Several bird-watering facilities have been installed. These watering stations collect precipitation and hold drinking water to last through the dry weather of spring and summer. They are placed as close as possible to food supply and shelter. In some areas plantings for food and shelter have been established after the watering stations were placed. Ducks feed and nest along perennial streams. Both ducks and geese fly off the Snake River to feed in nearby grainfields.

Deer are plentiful in uncultivated areas. They are usually along stream bottoms or in brushy areas on soils that face north or east. Coyotes are numerous and can often be heard at night.

Gwin-Linville association.-This association consists of extremely stony, steep and very steep soils that face south or west and of very steep soils that face north or east. About 95 percent of the association is used for range. Hungarian partridge and ring-necked pheasant find shelter and excellent areas for nesting and brooding. These birds feed on nearby farms. Chukars are plentiful in the extremely stony areas. California quail are numerous around livestock watering facilities and springs and along perennial streams.

Many springs in the area have not been developed to provide water for livestock. In these areas the soils are generally wet and are especially brushy. Other springs have been well developed and are used for watering places by both cattle and wildlife.

The brushy draws and the north- and east-facing slopes are suitable for deer. They provide ample food and shelter, and most are far from human habitation. Concentrations of coyotes are generally greater in this association than in most of the others. A few elk can be sighted in summer.

Gwin-Waha-Paloum association.-Most of the nearly level to steep areas of this association are being farmed. Extremely stony soils and those that are very steep are used for range. The range areas make up about 50 percent of the association. California quail and ring-necked pheasant are numerous, and there are scattered popula-

Figure 12.-Watering station for upland game birds. Food and shelter are nearby. The soil is Walla Walla silt loam, 7 to 25 percent slopes. This area is in NW1/4 sec. 34, T. 13 N., R. 41 E.

tions of Hungarian partridge. Chukars are plentiful in extremely stony areas. The intermittent patterns of land use make a favorable environment for nesting, brooding, and shelter.

Many springs and seeps in the area have not been developed to provide water for livestock. In these areas the soils are generally wet and are especially brushy. Other springs have been developed, and, along with perennial streams, furnish water for both livestock and wildlife.

The brushy draws and the north- and east-facing slopes provide good habitat for deer. Food and shelter are plentiful. At times, a few elk venture into these areas from the national forest to the south.

Larkin-Gwin-Tolo association.-About 58 percent of this association is used for the production of timber. Open ridgetops and open south- or west-facing slopes are used mostly for range but partly for farming.

Wildlife in this association consists mainly of deer, elk, and ruffed grouse, but there are also a few blue grouse and coyotes. These soils furnish ample food and shelter for wildlife. Perennial streams and stock-watering facilities provide water. Bobcats, mountain lion, and black bear occasionally wander into the area from the national forest to the south. Wild turkey and bighorn sheep have established themselves in areas near the Tucannon River.

Engineering Uses of the Soils

This section provides information of special interest to engineers, contractors, and others who use soil as a structural material or as foundation material upon which structures are built. Discussed in this section are those properties of the soils that affect construction and maintenance of roads and airports, pipelines, water storage

CHRISTIAN BAFUS, civil engineer, Soil Conservation Service, assisted with preparation of this section.

facilities, erosion control structures, and sewage disposal systems.

Information in this soil survey can be used in-

1. Planning and designing farm ponds, irrigation systems, terraces, diversions, grassed waterways, and other structures for controlling water and conserving soil.
2. Selecting potential locations for highways, air ports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, and residential areas.

With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, however, the soil map is useful for planning more detailed field investigations and for indicating the kinds of problems that may be expected. Soil areas shown on the map may include small areas of other soils that could not be shown separately on the map at the scale used.

Much of the information in this section is presented in the form of tables. Table 5 shows estimated properties significant in engineering, and table 6 gives engineering interpretations of the soils.

Some of the terms used in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary defines many such terms according to their meaning in soil science.

Engineering classification systems

Two systems of classifying soils for engineering purposes poses are in general use. Classification of the soils of- the Garfield County Area according to both of these systems is given in this survey.

The system used by the American Association of State Highway Officials (AASHO) (1) is based on field performance of soils in highways. In this system soil materials are classified into seven principal groups, designated A-1 through A-7, based on grain- size distribution, liquid limit, and plasticity index. The best materials for use in highway subgrades (gravelly soils of high bearing capacity) are classified as A-1, and the poorest (clayey soils that have low strength when wet) are classified as A-7. If soil material is near a classification boundary, it is given a symbol showing both classes, for example, A-2 or A-4. The estimated AASHO classification for all soils mapped in the survey area is given in table 5.

The Unified system of soil classification was developed by the Department of Defense (12). In this system soils are classified into 15 groups, according to particle-size distribution, plasticity, liquid limit, and organic-matter content. There are eight classes of coarse-grained soils, identified by the symbols GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified by the symbols ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified by the symbol Pt. The estimated classification for all the soils in the survey area, according to the Unified system, is given in table 5.

Estimated engineering properties

Table 5 gives estimates of soil properties important in engineering. The estimates are based on field classification and description, physical and chemical tests of selected samples, test data from comparable soils in nearby areas, and experience in working with soils of the survey area.

The dominant USDA texture given in the table was determined by the relative proportions of sand, silt, and clay in soil material made up of particles less than 2.0 millimeters in diameter. Some of the terms used in the USDA textural classification system are defined in the Glossary.

Permeability, as used in table 5, refers only to downward movement of water through undisturbed and uncompacted soil. It does not refer to lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils were not considered in preparing the estimates.

Available water capacity is the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Reaction is the degree of acidity or alkalinity of the soils, expressed as a range in the pH value. A pH value of 7 indicates a neutral reaction; a lower pH value indicates an acid reaction, and a higher pH value indicates an alkaline reaction.

Shrink-swell potential is an indication of the volume change to be expected if the moisture content of the soil changes. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates a hazard to the maintenance of structures constructed in, on, or with such material.

Corrosivity, as used in table 5, indicates the potential hazard to uncoated metal or concrete material. Structural materials may corrode when buried in a soil, and a given kind of material may corrode more rapidly in some kinds of soil than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or soil horizon.

Engineering interpretations

Table 6 contains information about soils as a source of topsoil, sand, gravel, and road fill. It also contains information about soil features that affect use of the soils for septic tank filter fields, sewage lagoons, foundations for low buildings, highway location, farm ponds, terraces and diversions, and grassed waterways. The interpretations in the table are based on information in table 5 and on field experience. Although the information applies only to the soil depths given in the table, it is reasonably reliable to a depth of about 6 feet for most soils and to a greater depth for others.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means that soil properties generally are favorable for the rated use, or in other words, imitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special designs.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Formation and Classification of the Soils

This section tells how soil-forming factors have affected the formation of the soils of the Garfield County Area. It explains the system of classifying soils and contains a table that shows the classification of the soils by higher categories.

Factors of Soil Formation

Soil is the product of the interaction of five major factors: parent material, climate, relief, living organisms, and time. Soils differ according to the relative degree of influence of each of the soil-forming factors. These factors and their influence on the soils of this survey area are discussed in the following paragraphs.

Parent material

The soils of the Garfield County Area formed in materials derived mainly from loess (periglacial nonmarine sediments), material weathered from basalt, glacial outwash, eolian sand, and volcanic ash.

The loess covers at least two-thirds of the survey area. It is part of a larger deposit that extends from east-central Oregon, north-northeast along the western slope of the Blue Mountains, across southeastern Washington, and into Idaho. The origin and nature of these materials were first discussed by Russel (5) and later by Calkins (3) and Salisbury (6). These and later investigators refer to this as the Palouse Formation. The formation consists of several layers of firm silty material, commonly called loess.

In this survey area the loess of the Palouse Formation was deposited on a strongly dissected basalt plateau to depths of as much as 100 feet. After the last glaciation, this older loess was covered with a few feet of younger, less compact loess. This thin mantle of loess was deposited after the Palouse Formation was eroded to its present topography.

Rieger made counts of the light and heavy mineral species of the various layers of the Palouse Formation. The latest deposition of loess contained enough volcanic mineral to distinguish it from the others. The Anders, Athena, Larkin, Palouse, and Tolo soils formed in these materials. The Tolo soils contain a much larger amount of volcanic ash than the other soils.

Throughout the Palouse Formation there are extensive but discontinuous layers of limy material. Some of these layers are strongly calcareous loess; others may have been deposited in old lake basins. All were strongly eroded before being covered by new deposits of loess. In the Asotin soils some 6 to 10 inches of this material rests on the bedrock. In the calcareous phases of the Athena soils, these materials are 40 to 60 inches below the surface. In the Oliphant soils these limy materials are at depths of 20 to 40 inches. The limy materials have a calcium carbonate equivalent of more than 15 percent. The Lance soils (mapped in a complex with Athena soils) have a limy surface layer. It appears that the later depositions of loess have been lost through erosion, and the present soil contains layers of soft calcareous loess and lenses of hard caliche cemented in part by silica.

The volcanic rocks of Miocene age are part of the large Columbia River basalt flow. In this survey area the basalt flow has been tilted to the north by the uplift of the Blue Mountains. Exposures in the Snake River canyon and in the Blue Mountains to the south indicate that the flow is at least 2,000 feet thick. Hard granitic rock is exposed below the basalt at one point in the Snake River canyon.

In most places the basalt is very slightly weathered and its role in soil formation is primarily mixing fragments of basalt with the loess. The fragments range from the size of fine sand to the size of large cobblestones or stones. This mixture of parent material is characteristic of the contact between the loess and basalt in soils that are less than 40 inches thick over the basalt. Anders and Asotin soils, for example, are 20 to 40 inches thick and contain as much as 30 percent coarse fragments in the few inches of loess just above the contact. In places the Klicker and Waha soils have 30 to 70 percent coarse fragments in the material above the contact. Anatone, Bakeoven, Gwin, and Lickskillet soils are less than 20 inches thick and have coarse fragments of basalt throughout the solum. The clay in the lower part of the B horizon of the Anatone soils is probably the result mostly of the weathering of basalt.

Alluvial soils are of recent deposition. In this survey area such soils are those of the Henningsen, Hermiston, Mondovi, and Onyx series. These soils are in small areas along the major streams. With the exception of the Henningsen soils, which have a substratum of gravel, they formed in deep layers of alluvium washed from adjacent uplands.

At the close of the Pleistocene epoch the glacial ice melted. As the ice melted, streams flowing from the ice deposited thick beds of sorted gravel and sand on terraces and plains and in stream valleys. This material, called glacial outwash, is generally sandy and gravelly and is underlain by nearly clean sand or gravel. The Benge soils formed in glacial outwash covered by a thin mantle of loess. The Chard soils formed in a mixture of glacial outwash and loess.

Wind-deposited sand is the parent material of the Quincy soils.

RIEGER, SAMUEL. DEVELOPMENT OF THE A2 HORIZON IN SOILS OF THE PALOUSE AREA. Unpublished thesis, Library of State College of Washington, Pullman. 1952.

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Climate

Climate directly affects the formation of soil through its influence on weathering of rocks, on soil erosion, and on plant growth. It helps determine the kind and density of plants that grow in an area. Temperature and precipitation are the main climatic factors in soil formation.

The mean annual temperature in the survey area does not vary more than about 10° F. At elevations of more than 3,000 feet, the soils generally formed under a mean annual temperature of less than 45°. In January the mean temperature is the low twenties. Soils that formed under these conditions are those of the Anatone, Klicker, and Tolo series.

At elevations of less than 3,000 feet, the mean annual temperature is between 45° and 55°. In December, January, and February the average daily temperature ranges from 25° to 40°. When the ground is frozen, rapidly melting snow and rainfall cause excessive runoff and severe erosion. The average temperature in June, July, and August ranges from about 65 ° in the Blue Mountains to about 75 ° at Wawawai. During this period the potential evaporation rate is approximately seven times the average rainfall for the same period.

In this survey area the annual precipitation ranges from about 12 inches at Central Ferry to about 30 inches at Peola. Precipitation is light (generally less than 1 inch) in July and August. It gradually increases in fall and reaches a peak about midwinter. In spring, precipitation gradually decreases, then drops sharply in July. This precipitation pattern favors deep-rooted plants that are able to draw upon water stored deep in the soil.

Shallow-rooted plants mature and become dormant during the dry season. Soils that are less than 30 inches deep do not store enough water to sustain maximum plant growth during the dry season. In the wet season the shallow soils become saturated, and much of the annual precipitation is lost through runoff.

Relief

Relief influences soil formation through its effect on drainage, runoff, and erosion. Sunshine is much less effective in warming the soil and evaporating moisture on north-facing slopes than on south-facing slopes. Consequently, soils on north-facing slopes are more moist, are darker colored, and support more vegetation than soils on south-facing slopes. Much of the mountainous part of the survey area supports forest on north- and east-facing slopes and open forest and grassland on summits and south- and west-facing slopes.

The Garfield County Area has four major types of relief. One type, in the northwestern part of the county, consists of dissected terraces, alluvial fans, toe slopes, and bottom lands. This area is at elevations of 600 to 1,400 feet; precipitation is lower in this area and temperatures are higher. Soils of the Chard series are representative of this type of relief; these soils are sloping and well drained.

The second type of relief consists of undulating and. rolling uplands on the basalt plateau. This is the most extensive of the four types of relief in the county. Most of the soils are sloping and well drained. Soils having south- and west-facing slopes are generally shallower to calcareous loess than soils having east- and north-facing slopes. Soils that face east and north are cooler and lose less moisture through evaporation than soils that face south or west. The additional moisture permits deeper leaching of lime. Soils of the Athena and Walla Walla series are representative of this type of relief.

Another type of relief consists of steep slopes along drainageways descending from the basalt plateau. The soils are extremely stony and shallow. They are mostly on south- and west-facing slopes in positions that received little or no deposition of loess or where water erosion has washed away the loess about as fast as it accumulated. Soils of the Gwin and Lickskillet series are representative of shallow soils on the basalt plateau. On many of the east- and north-facing slopes, the lee sides of drainageways received more loess, and the soils are deeper. Soils of the Linville series are representative of the deeper soils on the basalt plateau.

The fourth type of relief consists of hilly and mountainous uplands. Elevations where this kind of relief is dominant range from 3,000 to 4,500 feet. The growing season is shorter at these elevations and more of the precipitation is in the form of snow than at the lower elevations. These conditions favor a forest type of vegetation. Soils that formed under forest are more acid than those that formed under grass, and their surface

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layer is lighter colored. Larkin and Tolo soils are representative of soils that formed on this type of relief. Larkin soils are generally on south-and west-facing slopes and receive less precipitation useful to plants than Tolo soils. Tolo soils lose organic matter faster through leaching than the Larkin soils, and their surface layer is consequently lighter in color.

Living organisms

Plant and animal life in and on the soil provide organic matter and bring plant nutrients from the lower to the upper soil horizons. The darkness of the color of the A horizon is directly related to the amount of organic matter in the soil. Vegetation is the main source of organic matter. Earthworms and burrowing animals help to mix the soil material, and bacteria and fungi change the organic matter into humus. Bacteria are more abundant than fungi in grasslands, and fungi are generally more abundant in the acid soils of forested areas.

The soils of the Garfield County Area formed under seven general types of plant associations. These are mixed grasses, grass-shrub, forest-shrub, forest, sagebrush-grass, bottom-land vegetation, and river terrace vegetation.

The largest plant association consists of mixed grasses, mainly bluebunch wheatgrass and Idaho fescue. The areas are generally in the northern part of the survey area. Grasses supply a. large amount of organic matter from their tops and roots. Micro-organisms, mostly bacteria, change the organic matter into dark-colored humus. The humus is mixed into the surface layer by percolating soil solutions and by the activity of earthworms and other animals that live in the soil. The humus gives the soils a very dark brown A horizon; in soils that formed under mixed grasses, the A horizon is about 15 inches thick. Man's activities, chiefly cultivation, have caused erosion in many places. The degree of erosion ranges from slight on nearly level soils to severe on many knobs and steep slopes, where nearly all of the surface layer has been lost. Soils of the Athena and Walla Walla series are representative of soils that formed under mixed grasses.

The grass-shrub plant association is in the southern part of the survey area. The principal native vegetation is bluebunch wheatgrass, Idaho fescue, Sandberg blue-grass, rose, lupine, and balsamroot. This kind of vegetation supplies large amounts of organic matter to the soils. The A horizon is black and 12 to 22 inches thick. Soils of the Gwin, Linville, Palouse, and Waha series are representative of soils that formed under grass-shrub vegetation.

The forest-shrub plant association is in the mountainous southern part of the survey area.. The vegetation consists chiefly of ponderosa pine, Douglas-fir, spirea, snowberry, and rose. Leaves and twigs from this type of vegetation are less easily decomposed into humus by fungi and bacteria than the organic matter from grasses. In soils that formed under forest-shrub vegetation, the A horizon is very dark brown and 3 to 12 inches thick. The roots of trees and shrubs, however, penetrate to bedrock and supply organic matter to the subsoil in the form of roots. Root channels left in the subsoil after the roots have decayed allow material from the surface layer to move downward. Logging has disturbed the vegetation in many areas, and erosion has removed much of the surface layer. Soils of the Flicker and Larkin series are representative of soils that formed under forest-shrub vegetation.

The forest plant association is also in the mountainous southern part of the survey area. The vegetation consists of Douglas-fir, white fir, scattered larch, ponderosa pine, and a few shrubs. Only a small amount of organic matter**,** in the form of twigs and mosses, is returned to the soils. Soils that form under this type of vegetation are generally reddish or light colored throughout the profile, and their dark-colored A1 horizon is very thin. In places the A1 horizon is entirely lacking. Soils of the Tolo series are representative of soils that formed under forest vegetation.

The sagebrush-grass plant association is throughout the survey area.. The vegetation consists of sagebrush and grasses. The grasses supply organic matter from their tops and roots, and micro-organisms decompose the organic matter into dark-colored humus. Soils of the Anatone and Bakeoven series are representative of soils that formed under sagebrush-grass vegetation. Bakeoven soils have a very dark brown A horizon. Anatone soils, which are on high mountain ridges, formed where grasses make up only a small part of the vegetation. They have a reddish or light-colored A horizon.

A plant association that consists chiefly of giant wildrye, redtop, willow, and sedges occurs on bottom lands in the northern part of the survey area. Soils that formed under this type of vegetation are associated with soils that formed under mixed grasses. Soils of the Hermiston series are representative. These are young soils that show little horizonation.

The smallest of the seven plant associations consists mainly of horsetail, rabbitbrush, and needle-and-thread. The areas are in a few places on terraces along the Snake River. Soils of the Quincy series are representative of soils that formed under this type of vegetation. These soils show little horizonation.

Time

Soil formation begins as soon as rock is exposed on the earth's surface, sediment rises above the surface of the water, or a fresh mantle of loess is laid down by the wind. As soil formation progresses, characteristic layers, called horizons, develop. Generally, a mature, or strongly developed, soil shows only faint or weakly developed horizons. The length of time required for a soil to develop depends on the nature of the parent material and the modifying effect of the other soil-forming factors.

The parent materials in this survey area. are of relatively recent origin. The basalt is of Miocene age, and the loess is of middle to late Pleistocene age. The stream sediments are recent; in many places they were deposited as recently as the early part of the twentieth century.

Soils of the Chard series are young. They have a distinct, dark-colored A horizon, but only a very weakly developed B horizon. The Walla Walla soils have a thicker, darker colored A horizon than the Chard soils, and they have a weak structural B horizon. The Athena soils have a thicker A horizon than either the Chard or Walla Walla soils, and they have a moderate structural B horizon that contains a few thin clay films. Soils of the Palouse series have a slight accumulation of clay in the B horizon. Soils of the Waha series have a dark-colored surface horizon and a textural B horizon.

Classification of the Soils

Classification consists of a. systematic grouping of soils on the basis of their characteristics. From such groupings, it is possible to organize knowledge about defined kinds of soils and to apply the results of experience and research to areas that range in size from several acres to millions of square miles.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (2) and later revised (9) . The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in March 1967 and September 1968 (11) . This system is under continual study, and readers interested in the development of the system should refer to latest available literature (7) .

Table 7 shows the classification of each of the soil series represented in the Garfield County Area according to the present system. This system defines classes in terms of observable or measurable properties of soils. The properties chosen are primarily those that permit the grouping of soils that are similar in genesis. The classification is designed to encompass all soils. It has six categories. Beginning with the most inclusive, they are the order, the suborder, the great group, the subgroup, the family, and the series. These are briefly defined in the following paragraphs.

ORDER.-Soils are grouped into orders according to properties that seem to have resulted from the same processes acting to about the same degree on the parent

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material. Ten soil orders are recognized in the current system : Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The Entisols, Inceptisols, and Mollisols are represented in the Garfield County Area.

Entisols are recent soils that lack well-developed horizons. In this survey area. this order is represented by soils of the Quincy and Lance series.

Inceptisols are soils in which horizons have begun to develop but are weakly expressed. This order is represented by soils of the Tolo series.

Mollisols are soils that have a thick, dark-colored surface layer. In this survey area all of the mapped soils, except those of the Quincy, Lance, and Tolo series, are representative of this order.

SUBORDER.-Each order is divided into suborders, primarily on the basis of soil characteristics that indicate genetic similarity. The suborders have narrower climatic range than the orders. The criteria. for suborders reflect either the presence or absence of waterlogging or soil differences resulting from climate or vegetation. The suborder is not given in table 7.

GREAT GROUP.-Each suborder is divided into great groups on the basis of uniformity in kind and sequence of genetic horizons. The great group in the current classification is not shown in table 7, because the name of the great group is the same as the last word in the name of the subgroup.

SUBGROUP.-Each great group is divided into subgroups, one representing the central (typic) concept of the group, and other groups, called intergrades, that have properties of one great group but also one or more properties of another great group.

FAMILY.-Families are established within subgroups, primarily on the basis of properties important to plant growth. Some of these properties are texture, mineralogy, reaction, soil temperature, permeability, consistence, and thickness of horizons.

SERIES.-The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile. A series is commonly given the name of a geographic location near the place where soils of that series were first observed and mapped.

Climate

The climate of the Garfield County Area has both marine and continental characteristics. The Rocky Mountains protect the Area from many of the cold arctic air masses moving southward, and the Cascade Range serves as a barrier to the easterly movement of moist air from the Pacific Ocean. The range in elevation from less than 2,000 feet in northern and central farming areas to 6,000 feet in the Blue Mountains results in several climatic zones within the county. Climatic data are given in tables 8, 9, and 10. Some of the data in these tables are based on records kept at stations in Asotin County.

At the lower elevations, the maximum temperature in summer generally ranges from 80° to 95° F., but reaches 100° nearly every year. A high temperature of 104° has been recorded at Anatone, and 112° at Clarkston Heights, Pomeroy, and Wawawai. The minimum temperature in summer is generally in the fifties. On the slopes of the Blue Mountains, the temperature can be expected to decrease approximately 4° with each 1,000 feet of elevation. Unusually hot weather seldom lasts for more than a. few days before cooler air from the Pacific Ocean moves inland.

In winter the maximum temperature ranges from 30° to 40° F., and the minimum temperature is in the twenties. The maximum temperature is below freezing on 20 to 35 days. The minimum temperature falls to 10° on 5 to 25 days and to zero or lower in most winters. During the winter of 1949-50, the minimum temperature at Pomeroy fell to zero or lower on 14 days and to -15° on 6 days. In 1968-69, a temperature of -27° was recorded on December 30, 1968. During the years 1930 to 1958, the average minimum temperature in January ranged from 4.1 ° in 1930 to 37.8 ° in 1958.

The amount of precipitation increases with elevation from 14 inches a year in the farming areas at the lower elevations to 45 inches a year on the upper slopes of the Blue Mountains. Precipitation is light in midsummer, increases in fall, reaches a peak in winter, then gradually decreases in spring. It increases again late in May and early in June, then drops sharply in July. The annual

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precipitation at Pomeroy has ranged from 9 to 26 inches. The average number of days each month with 0.10 inch of precipitation ranges from 1 in July to 7 in December.

Winter precipitation may be in the form of rain or snow at the lower elevations, but it is mostly snow in the mountains. In the farming areas snow can be expected at any time from the end of November until March. Snow seldom remains on the ground, however, longer than 3 to 5 weeks and seldom accumulates to a depth of more than 8 to 15 inches. In some of the more severe winters, snow has remained on the ground from the first of December until the end of February. On the upper slopes of the mountains, snow accumulates to adept of 6 to 9 feet and remains on the ground until late in spring. Occasionally, a chinook wind brings a sharp rise in temperature, and the melting snow results in rapid runoff and severe soil erosion.

Thunderstorms can be expected on 1 to 3 days each month from April through October. Hail and heavy rainfall intensities of 1 to 2 inches per hour, lasting for a -period of 5 to 10 minutes and accumulating 0.6 inch in an hour, can be expected once in 5 years.

The sun shines approximately 20 percent of the daylight hours in winter, 50 percent or more in spring and fall, and 85 percent in summer. In winter, there is considerable cloudiness, fog, and occasional freezing drizzle. Evaporation from lakes and reservoirs is about 32 to 40 inches a year.

Evapotranspiration is the loss of moisture from the soil by evaporation and by transpiration through the leaves and stems of plants. Techniques developed by Palmer-Havens for application of the Thornthwaite method (1948) (8) were used to compute the potential evapotranspiration given in table 8. The estimates of actual evapotranspiration are for normal conditions in soils that have a water-holding capacity of 6 inches. The potential evapotranspiration during the growing season is 15 to 20 inches, and the actual evapotranspiration is 8 to 10 inches.

Peak wind velocities can be expected to reach 60 to 70 miles per hour. The strongest winds are generally from the southwest. The prevailing winds are from the southwest from March through November. In winter, the prevailing winds are frequently from the east, but windspeed is usually less than 20 miles per hour.

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Glossary

Bottom land. Low land formed by alluvial deposits along a river. Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) .to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils -of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Cobbly. Soils having rounded or partly rounded fragments of rock ranging from 3 ,to 10 inches in diameter.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are-

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material, .and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard .and brittle; little affected by moistening.

Contour tillage. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

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Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors, such as light, moisture, temperature, and the physical condition of the soil are favorable. Terms used in this survey are relative and apply only in relation to other soils in Garfield County Area. The terms are *low*, *medium*, and *high*.

Horizon, soil. A layer of soil, approximately parallel to the Surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons

0 horizon.-The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.-The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum,

C horizon.-The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Lacustrine deposit (geology). Material deposited in lake water and exposed by lowering the water table or elevation of the land.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Minimum tillage. No more tillage than is absolutely necessary for seedbed preparation, planting, and cultivation.

Mulch tillage. Tillage or preparation -of soil in such a way that plant residue is left on the surface.

Outwash plains. Built-up debris, where the land relief is low, that has been brought to a glacier end by melt water drainage and carried away by the outflow streams where the slope of the land is away from the ice.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: very slow, slow, moderately slow, *moderate, moderately* rapid, rapid, and very rapid.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus

	pH		*pH*
Extremely acid---	Below 4.5	Neutral ----------	6.6 to 7.3
Very strongly acid-	4.5 to 5.0	Mildly alkaline------	7.4 to 7.8
Strongly acid-----	5.1 to 5.5	Moderately alkaline-	7.9 to 8.4
Medium acid-----	5.6 to 6.0	Strongly alkaline----	8.5 to 9.0
Slightly acid-----	6.1 to 6.5	Very strongly alkaline _____	9.1 and higher

Rough fall tillage. An effective erosion control practice. Early in fall, after harvest, the soil is plowed while the ground is dry. For a fall-seeded crop, fertilizer is applied and the soil is seeded without further seedbed preparation. For a spring crop. the soil is left rough through the winter.

Runoff. The rate that water is removed by flow over the surface of the soil. Rapidity of runoff and the amount of water removed are affected by slope, both gradient and length; by texture, structure, and porosity of the surface layer; by vegetative cover; and by climate. The rate of runoff increases markedly if the surface layer is pulverized, frozen, or saturated during periods of rain or when snow melts. Terms used in this report are relative assuming a bare surface. Terms are very slow, slow, medium, rapid, very rapid.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Saline-alkaline soil. A soil that contains harmful concentrations of salts and exchangeable sodium, or contains harmful salts and has a highly alkaline reaction, or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction are so distributed in the soil that growth of most crop plants is less than normal.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are-*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. Structureless soils are either single grain (each grain by itself, as in dune sand) or massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residue left on the surface of the soil to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface tillage. Tillage with a sweeplike plow or blade that does not turn over the surface cover or incorporate it into the lower part of the surface soil.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream .terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy* loam, loam, silt loam, silt, *sandy* clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Uphill plowing. Tillage operations in which the furrow slice is turned up the slope instead of down. Effective on soils that have slopes of up to approximately 25 percent.

Usable forage. The plant growth that livestock may graze without injuring the vigor of the plant, or approximately 50 percent of the year's growth.

Volcanic ash. Small, generally porous; fragments of pumice or obsidian that have been ejected by volcanoes.